CHARLES E. SMITH
President, 1916-17

C. A. LICHTY
Secretary-Treasurer

PROCEEDINGS OF THE

Twenty-Sixth Annual Convention

OF THE

American Railway Bridge and Building Association

Successor to the

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF
BRIDGES AND BUILDINGS

HELD AT

NEW ORLEANS, LA.

OCTOBER 17-19, 1916

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Chicago & Northwestern Ry., Chicago.

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THE EXECUTIVE COMMITTEE.

Consists of the Officers and the Following Members:

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ARTHUR RIDGWAY, Denver & Rio Grande R. R., ...Denver, Colo.
J. S. ROBINSON, Chicago & Northwestern Ry., ...Chicago, Ill.
J. P. WOOD, Pere Marquette R. R., ...Saginaw, Mich.
D. C. ZOOK, Pennsylvania Lines West, ...Ft. Wayne, Ind.

PAST PRESIDENTS

1891-92	*O. J. Travis,	Pinehurst, Wash.
1892-93	*H. M. Hall,	Ohio & Mississippi Ry., Olney, Ill.
1893-94	*J. E. Wallace,	Wabash R. R., Springfield, Ill.
1894-95	G. W. Andrews,	Baltimore, Md.
1895-96	W. A. McGonagle,	D. M. & N. Ry., Duluth, Minn.
1896-97	James Stannard,	Kansas City, Mo.
1897-98	*Walter G. Berg,	Lehigh Valley R. R., New York City
1898-99	J. H. Cummin,	Bay Shore, N. Y.
1899-00	A. S. Markley,	Chicago & Eastern Illinois R. R., Danville, Ill.
1900-01	W. A. Rogers,	37 W. Van Buren St., Chicago, Ill.
1901-02	W. S. Danes,	Wabash R. R., Peru, Ind.
1902-03	B. F. Pickering,	Boston & Maine R. R., Salem, Mass.
1903-04	A. Montzheimer,	Elgin, Joliet & Eastern Ry., Joliet, Ill.
1904-05	C. A. Lichty,	Chicago & Northwestern Ry., Chicago, Ill.
1905-06	J. B. Sheldon,	N. Y. N. H. & H. R. R., Providence, R. I.
1906-07	J. H. Markley,	Toledo, Peoria & Western Ry., Peoria, Ill.
1907-08	R. H. Reid,	L. S. & M. S. Ry., Cleveland, O.
1908-09	J. P. Canty,	Boston & Maine R. R., Fitchburg, Mass.
1909-10	J. S. Lemond,	Southern Ry., Charlotte, N. C.
1910-11	H. Rettinghouse,	C. St. P. M. & O. Ry., St. Paul, Minn.
1911-12	F. E. Schall,	Lehigh Valley R. R., So. Bethlehem, Pa.
1912-13	A. E. Killam,	Moncton, N. B.
1913-14	J. N. Penwell,	L. E. & W. R. R., Tipton, Ind.
1914-15	L. D. Hadwen,	C. M. & St. P. Ry., Chicago, Ill.
1915-16	Geo. W. Rear,	Southern Pacific Co., San Francisco, Cal.

*Deceased.

SUBJECTS AND COMMITTEE APPOINTMENTS FOR 1916-17

1. The Construction of Shop Buildings.

J. S. Robinson, C. & N. W. Ry., Chicago.
E. T. Howson, Ry. Maint. Engineer, Chicago.
A. B. Nies, M. C. R. R., Jackson, Mich.
A. S. Markley, C. & E. I. R. R., Danville, Ill.
A. T. Hawk, C. R. I. & P. Ry., Chicago.
E. B. Ashby, L. V. R. R., New York City.
H. B. Stuart, G. T. R., Montreal, Que.

2. Erection of Plate Girder Spans with the Least Interruption to Traffic.

Lee Jutton, C. & N. W. Ry., Madison, Wis.
C. W. Wright, L. I. R. R., Jamaica, N. Y.
J. S. Huntoon, M. C. R. R., Detroit, Mich.
J. G. Bock, C. St. P. M. & O. Ry., St. Paul, Minn.
C. U. Smith, C. M. & St. P. Ry., Milwaukee, Wis.
S. T. Corey, C. R. I. & P. Ry., Chicago.

3. Roof Drainage of Railway Buildings.

E. S. Meloy, C. M. & St. P. Ry., Chicago.
E. R. Floren, C. R. I. & P. Ry., Rock Island, Ill.
E. F. Gardner, Erie R. R., Buffalo, N. Y.
B. F. Gehr, P. C. C. & St. L. Ry., Richmond, Ind.
Maro Johnson, I. C. R. R., Chicago.

4. Repairing and Strengthening Old Masonry.

A. I. Gauthier, B. & M. R. R., Concord, N. H.
W. F. Strouse, B. & O. R. R., Baltimore, Md.
J. B. Sheldon, N. Y. N. H. & H. R. R., Providence, R. I.
W. S. Bouton, B. & O. R. R., Baltimore, Md.
W. H. Moore, N. Y. N. H. & H. R. R., New Haven, Conn.
B. W. Guppy, B. & M. R. R., Boston, Mass.
G. A. Rodman, N. Y. N. H. & H. R. R., New Haven, Conn.
J. P. Canty, B. & M. R. R., Fitchburg, Mass.
G. T. Sampson, N. Y. N. H. & H. R. R., Boston, Mass.
H. C. McNaughton, N. Y. N. H. & H. R. R., Concord, N. H.

5. Hand Operated Devices for Lifting, Pulling and Hoisting.

C. H. Fisk, Cons. Engr., 5142 Westminster Pl., St. Louis, Mo.
R. J. Bruce, Mo. Pac. Ry., St. Louis, Mo.
J. S. Berry, S. L. S. W. Ry., St. Louis, Mo.
A. S. Markley, C. & E. I. R. R., Danville, Ill.
A. O. Cunningham, Wabash R. R., St. Louis, Mo.

6. Paint and Its Application to the Exterior of Railway Buildings.

Chas. Ettinger, I. C. R. R., Chicago.
J. N. Penwell, L. E. & W. R. R., Tipton, Ind.
J. B. Gaut, G. T. R., Chicago.
J. S. Huntoon, M. C. R. R., Detroit, Mich.
A. F. Miller, P. R. R., Chicago, Ill.

7. Fireproofing Roofs of Wooden Buildings.

J. B. Gaut, G. T. R., Chicago.
A. T. Hawk, C. R. I. & P. Ry., Chicago.
John Miller, C. & N. W. Ry., Chicago.
P. Aagaard, I. C. R. R., Chicago.

8. Organization of the Water Service Department.
Economical Delivery of Water to Locomotives.

C. R. Knowles, I. C. R. R., Chicago.
L. A. Cowsert, C. N. O. & T. P. Ry., Danville, Ky.
H. A. Horning, M. C. R. R., Jackson, Mich.
M. B. Miller, 706 Transpn. Bldg., Chicago.
R. C. Henderson, B. & O. R. R., Garrett, Ind.

9. Blank Forms for Water Service Records.

F. E. Weise, C. M. & St. P. Ry., Chicago.
C. R. Knowles, I. C. R. R., Chicago.
F. M. Case, C. & N. W. Ry., Belle Plaine, Ia.
J. Dupree, 7208 Peoria St., Chicago (C. T. H. & S. E. Ry.).
E. A. Demars, O. S. L. R. R., Salt Lake City, Utah.

10. Snow Sheds.

A Paper by Geo. W. Rear, S. P. Co., San Francisco, Cal.

11. Efficient Methods of Handling Work and Men.

Arthur Ridgway, D. & R. G. R. R., Denver, Colo.
A. W. Pauba, C. & S. Ry., Denver, Colo.
A. H. King, O. S. L. R. R., Pocatello, Idaho.
J. L. Talbott, A. T. & S. F. Ry., Pueblo, Colo.
F. M. Bigelow, L. A. & S. L. R. R., Salt Lake City, Utah.

NOMINATIONS.

R. H. Reid, N. Y. C. R. R., Cleveland, O.
S. F. Patterson, 35 Pleasant St., Concord, N. H.
L. D. Hadwen, C. M. & St. P. Ry., Chicago.
J. P. Canty, B. & M. R. R., Fitchburg, Mass.

SUBJECTS.

F. E. Weise, C. M. & St. P. Ry., Chicago.
F. G. Jonah, S. L. & S. F. R. R., St. Louis, Mo.
R. C. Sattley, C. R. I. & P. Ry., Chicago.

MEMBERSHIP.

J. D. Moen, C. St. P. M. & O. Ry., St. Paul, Minn.
G. A. Manthey, Soo Line, Minneapolis, Minn.
A. S. Clopton, M. K. & T. Ry., Oklahoma City, Okla.
A. W. Reynolds, P. R. R., Jersey City, N. J.
A. J. James, A. T. & S. F. Ry., Topeka, Kans.
A. W. Smith, C. N. Ry., Winnipeg, Manitoba.
Frank Lee, C. P. R., Winnipeg, Manitoba.
Frank Ingalls, N. P. Ry., Jamestown, N. D.

RELIEF.

A. Montzheimer, E. J. & E. Ry., Joliet, Ill.

PUBLICATIONS.

R. C. Sattley, C. R. I. & P. Ry., Chicago.
C. J. Scribner, C. B. & Q. R. R., Chicago.
I. L. Simmons, C. R. I. & P. Ry., Chicago.

ARRANGEMENTS.

H. Rettinghouse, C. St. P. M. & O. Ry., St. Paul, Minn.
W. A. McGonagle, D. M. & N. Ry., Duluth, Minn.
J. A. Bohland, G. N. Ry., St. Paul, Minn.

OBITUARY.

B. F. Pickering, B. & M. R. R., Salem, Mass.

Proceedings of the Twenty-sixth Annual Convention

of the

American Railway Bridge and Building Association

Held at the Hotel Grunewald

New Orleans, La., October 17-19, 1916

MORNING SESSION.

Tuesday, October 17, 1916.

The twenty-sixth annual convention was called to order by the president, G. W. Rear (Southern Pacific Company, San Francisco), at 10 a. m., in the gold room of the Hotel Grunewald.

The President:—Ladies and Gentlemen: We will now proceed to open this, the twenty-sixth convention of this association. Following the established custom, we will open with prayer. I ask you to kindly rise.

(Prayer was then offered by C. A. Lichty, secretary-treasurer.)

The President:—We consider that we are very fortunate in being able to meet at this time in this city after an absence of 21 years. In making arrangements for some one to welcome us we undertook to get the mayor, but when we found that he was the same mayor who was in office when we met here previously, we asked him to send somebody a little newer (laughter). He has sent one of his associates, Mr. Harold W. Newman, commissioner of public safety of the City of New Orleans, who will address us in behalf of the city.

Harold W. Newman:—Ladies and Gentlemen: I am sure that the words of your good president, intended to bring a representative of the City of New Orleans to the platform with as much of a feeling of ease and comfort as possible, embarrassed me somewhat, because our good mayor has served the City of New Orleans as its mayor for 12 years, and will serve us for 4 years more, as he is the unopposed candidate for re-election. Our mayor has always taken a leading part in bringing to the City of New Orleans conventions

for the reason that, aside from any of the benefits that might accrue to the visitors, he has felt that it was an impetus, an incentive to our home people to endeavor, by their improvements, to present to the world this city's desire for progress at home; and I know of no convention that might come to the City of New Orleans that could give the mayor and the people of the city more cause for genuine gratification than this association. I say this because, without any desire to pay undue flattery to your organization, I take it that you yourselves must realize that, in the great constructive efforts that have been made so far to place this whole country on the plane that it occupies today, no organization or set of men could have done more to reach that position than this organization and its membership, who are the railway bridge and building men of the country.

There is no question but that, even considering the great industrial development of this country, the railways and all of their constituent enterprises have done more than any other single branch of industry in this country to bring America to the point she occupies today. New Orleans is only expressing a sentiment which we feel is nation-wide, that of all the conventions which will gather in this city or elsewhere during the coming season, this association of bridge and building people will represent a class of men who have been the real builders of prosperity in this country (applause).

The City of New Orleans has been undergoing, for many years past, a constructive era. Up to possibly 12 or 14 years ago the people were content to be the beneficiaries of what they considered their natural opportunities. We were situated in a position where the founders of this city had felt that New Orleans was bound to become one of the great cities of this continent, and we were content simply to reap the benefits which were bound to come to us because of our location. I don't care to tire you, because I notice in the letter which was written to the mayor and which was handed to me, that the secretary of this association asked for a short speech, and I am convinced that, when it comes to technical ability and technical knowledge, the members of this association want a short speech. The committee walked me up the steps, instead of giving me the benefit of the elevator, and you can be sure that the speech will be short (laughter).

There is no question about the warmth of the welcome that this city extends to the members and the ladies of this convention. Immediately after the in-coming of our present mayor there was a general realization that we could not rest our claims to becoming

or to become the great city that our natural advantages would aid in making us, and, following a period of pestilence, flood and other calamities which unfortunately visited us, New Orleans set about to build one of the great water plants of this country with a purification system, sewage and drainage systems and monster cotton and grain elevators, and we are preparing today to be judged and take our position in the race for supremacy with the leading cities of this country. We ask you to look us over. If there be aught in which we have any short-comings—and I am sure there are some—we will be thankful to you for such advice and suggestions as you can give.

The City of New Orleans, through me as the representative of our mayor, extends to each and every one of you that character of welcome which we trust you will not consider perfunctory or purely a formal one. We want you to feel, as we have hoped all of our visitors have felt for many years, that you are here as members of a household visiting our family. We would like you to feel that the city government and the people would esteem any call of any character by you, Ladies and Gentlemen, upon us, not as a favor extended to you, but as a pleasure on our part. We believe, in the words of our mayor, that if you have once come to New Orleans you will be sure to come again. My only wish is that the intervening time will not be 21 years, as it is this morning. I thank you (applause).

The President:—Probably only a few of us realize the importance of this city as a railroad center. I know for myself that I hardly realized that the City of New Orleans was such a great railroad terminal. One of the railroads that has its terminal here has sent its general superintendent to welcome us, and I now call on Mr. Downs, general superintendent of the Illinois Central (applause).

Mr. L. A. Downs:—Ladies and Gentlemen: I assure you that it is a pleasure to me to welcome this association to New Orleans, as the representative of the railroad officials in this city. I was quite pleased with what Mr. Newman, the representative of the mayor, said, when he spoke of the important place you fill in the world's work. in your bridge and building work. No one knows better than myself or other railroad officials the important place that the bridge and building department fills in the railroad organization. No one knows better than those who have fought floods and cleared wrecks, how important a bridge gang or a building gang is in times of trouble; and I can say to you men here without fear of contradiction, and it is something that could hardly be said of any other depart-

ment of a railroad, that there are fewer bridge and building men dismissed for incompetency than in any other department of our railroads (applause). If you doubt the truthfulness of that statement, you know the conditions on your own railroad. If you will turn back just a minute and think about it, you will find that I am right.

I am glad that you came to New Orleans just at this time because New Orleans is a great city. There are 14 railroads running in here, and no other city, except New York, is greater than New Orleans with respect to its export and import traffic. This is the second port in the United States and, therefore, it is well that you have come here. Did you know that New Orleans is the greatest market for cotton, for nitrate, for sugar, molasses, for cigars, for cigarettes, and for bananas, of any city in the United States? So we occupy a place by ourselves; and we are interested in the railroads for they must necessarily bring in and take out all of this export and import stuff.

We have a public belt in New Orleans, the only one in the United States, more than 60 miles long, connecting all the railroads with the docks, wharves and other railroad facilities. We have 40 miles of docks and wharves, and while you are here we hope that you will inspect our great elevators, our iron docks and everything pertaining to the railroads. The railroads in New Orleans would be interesting of themselves alone. Mr. Newman has welcomed you in behalf of the city, but I desire to extend to you a most cordial welcome on the part of the railroads, and to give you a master switch-key that will unlock all the switches of all the railroads in New Orleans, and you are welcome to go on those tracks at any time you wish. I thank you (applause).

The President:—On behalf of the association I will ask C. E. Smith, our first vice-president, to respond.

C. E. Smith (Cons. Engr., St. Louis):—Mr. Newman and Mr. Downs, it gives me great pleasure to thank you on behalf of the American Railway Bridge and Building Association for the very kind and cordial welcome you have extended to us this morning. New Orleans has possessed a great interest to all of us for a number of reasons; for business reasons and for romantic reasons. From a business standpoint New Orleans has shown that it has forged ahead under the able leadership of Mayor Behrman, to a position only second to New York as a shipping port, and has overcome obstacles which would seem to the average individual to be

insurmountable. The people of New Orleans have set an example to all other cities of coöperation, harmony and unity in the government of their affairs which it would be well for them to learn and follow. That is perhaps best exemplified by Mr. Newman's statement that Mayor Behrman has already been mayor of this city for 12 consecutive years, and he is about to enter upon another term of 4 years more, which will make 16 years, a record that, I think, is unparalleled in any other large city of the United States, and is a great credit, not only to Mayor Behrman, but to his constituents in New Orleans (applause).

New Orleans possesses a peculiar significance to the members of this association, and especially to the ladies, from a romantic standpoint, located as it is in the heart of the land made immortal by Longfellow's Evangeline. I believe all of us know the story of the Acadians, in which it is pictured how they settled in this general territory and wended their way up the Mississippi river. A great deal of the advancement of New Orleans, a great deal of the efficiency of the people, of their harmony and unity, is the result of the stock that was brought in about that time. There are many descendants of the Acadians here now. There are many Gabriels and Evangelines, and they are as loving as the Evangeline and Gabriel of Longfellow's story. There is no fear of rivalry here, because our Gabriels have brought their Evangelines with them; but had it been otherwise, I am afraid some of your Gabriels would have lost some of their Evangelines before leaving town (laughter).

I thank you very heartily for the kind and cordial welcome which you have extended to us (applause).

On motion the reading of the minutes of the last meeting was dispensed with.

The President:—The next order of business is the president's address.

PRESIDENT'S ADDRESS.

As it is probably known, this convention marks the closing of the twenty-fifth year of life of this Association. In opening the second quarter of a century it is probably well for us to pause and look back over the way we have come, to see whether the Association is founded on right lines, and whether we are still on the upgrade.

Twenty-five years ago a small body of men met in St. Louis to form this Association. They believed that there was a demand for this Association, an association where men could meet and, in the exchange of ideas, combine their wisdom and their experiences, could meet and, after enjoying the fellowship of men in similar walks of life, leave for their homes and again take up their work with renewed confidence and inspiration.

The results of this Association's work probably give the best idea as to whether it was founded on right lines or not. In looking back over the reports for 25 years, one is impressed by two main thoughts; first, the zeal and energy exhibited by the members in preparing the reports, and the enthusiastic part they took in the discussions of these conventions; and second, the great development that has taken place in the railroads and in their appliances and structures. Twenty-five years ago the rolling mill was just beginning to assume ascendency over the sawmill. At that time the use of concrete was only in its infancy.

The Association is made up of men in all branches of the railroad service. A large number of the higher officials of the railroads have retained their membership in this Association after having been promoted to positions of more authority, and the interest that they maintain in this Association is but another evidence that it is founded on proper principles and is working along the right lines. From its organization the loyalty and sociability of its members have been conspicuous, and many have been untiring in their efforts to further its interests.

Very early in the Association's history the members began bringing their wives and daughters to the conventions, and from this alone a large amount of the success of the Association is due. If you will look at the women who accompany the men to these meetings, you will say that they are fit companions for the men they accompany; and they are that class of women upon whom the world depends for its betterment (applause).

One of our past presidents who recently passed away, paid a tribute to our secretaries. I am not going to say anything in regard to the present secretary. During the past year I had an opportunity to look over the work of the man who was our secretary for 18 years, who has now been retired for a few years. In looking over his work I feel that the welfare of the Association depended almost entirely on our first secretary. The extraordinary ability shown in getting the Assoc'ation on its feet, the painstaking record of its history, the minute details with which he carried on its affairs, convinced me that we were extremely fortunate in finding such a man to fill that position. Before closing we will introduce this first secretary.

Our affairs as an Association are in a very satisfactory condition. The finances for this year are extremely satisfactory.

Within the last few weeks we were all heartbroken when we heard of the disaster in connection with the world's greatest bridge at Quebec. Some of you probably do not know that the president of the St. Lawrence Bridge Company is a member of this Association. The members of this Association are filled with sympathy for him. We rejoice in the spirit with which he has taken hold of that matter and feel, before this convention meets again, that gap will be closed and the greatest engineering feat of the world's history will have been accomplished.

There are other gaps in the railroad situation that will not be so easily spanned. I believe that there are men who can design and span any of Nature's chasms, but there is a chasm appearing in the railroad situation that seems at the present time to be impossible to bridge. I do not refer to the chasm that existed for some time between the shippers and the transportation companies. This chasm is gradually closing up and disappearing. There is a possibility that there was not a chasm there at all, but that there was a fog or haze that divided the two sides and they imagined there was a chasm when there was not. The chasm I refer to this morning is that between the railroad companies and some of their employees, backed up, or at least encouraged, by some of the public authorities. I feel that this Association will have to use its best endeavors to bridge that gap. This Association is probably the last branch of railway service where the men work because they are part of the great organization and they desire to accomplish something. I believe that one of the main reasons, in fact the only reason, that the men in this branch of railway service are as loyal to their employers as they

are, is because the heads of the departments have struggled along with the men in this department in times of stress and washouts, when it would seem impossible for men to do anything but feel the best respect for the men under them, when they see what they go through, and the men must have loyalty to their superiors when they know they will go through those same hardships and take the same chances as the men. They appear like an army fighting in the trenches, that, after leaving the trenches, could never get back on divided lines, for the officers and men feel that they are bound up in each other (applause).

I wish to thank the officers and members of this Association for the help they have been to me in the past year, and take this opportunity, when you are all here together, to say that at the end of this convention, when I retire from the office of president, I hope to follow the example of previous past presidents and continue to work in the interest of this Association, believing as I do and as they all have believed, that the game is more than the player, and the game and the ship are more than the crew (applause).

The President:—All of the older members here are very well acquainted with our friend, the "Deacon," who was for so many years our secretary. I would like to have him come on the platform and be introduced to the newer members, who have not met him.

(The secretary-treasurer then escorted Mr. Patterson, secretary emeritus, to the platform, amid applause.)

The President continued:—Ladies and gentlemen, allow me to introduce to you Mr. Patterson, familiarly known to us all as the "Deacon." He served this association from its infancy, for 18 years as secretary. All of us hated to permit him to resign the office, and we have retained him as an honorary secretary. We want all of you to take hold of the "Deacon" and use him the same as we always have (applause).

Before dismissing you I wish to urge that all of the members of this Association act and feel as one family. We have some new members here today and some who have not attended a convention. We want them to feel that they are as welcome as any of the older ones, and we do not want them to stand back at all but rather to enter into and take part in the work of the Association.

We had intended to declare a recess now until two o'clock, but there are one or two matters that we want to take up right away. We will request F. E. Weise to act as assistant secretary during the convention. We have the usual registration cards here, and we want to be sure that everybody registers.

Before taking up the reports and discussions at this convention the chair has in mind that at previous conventions there had been a considerable amount of wandering from the subject in the discussions. The chair believes that the prime object of this Association is to trace down and find out anything that will be of information to

the members. He will, therefore, be inclined to permit any wandering from the subject that appears to be leading us somewhere, but it is to be hoped that we will try to keep inside the right-of-way fence.

Roll call was dispensed with and the names of those present were secured by the card registration system which showed the following members as being present:

P. Aagaard
W. E. Alexander
F. W. Bailey
F. C. Baluss
E. K. Barrett
C. L. Beeler
Henry Bender
J. M. Bibb
S. H. Blowers
Stanton Bowers
S. C. Bowers
J. B. Browne
R. J. Bruce
E. J. Buckley
D. Burke
J. M. Caldwell
W. M. Camp
J. P. Canty
W. M. Cardwell
F. M. Case
W. W. Casey
A. J. Catchot
W. M. Clark
A. S. Clopton
F. J. Conn
W. S. Corbin
D. E. Counts
L. A. Cowsert
J. Dupree
T. H. Durfee
H. A. Elwell
Chas. Esping
C. Ettinger
C. H. Fake
Franklin Gable
A. I. Gauthier
B. F. Gehr
Ira Gentis
J. F. Glasgow
Jas. Gratto
F. M. Griffith
L. D. Hadwen
W. C. Harman
W. Hausgen
J. Henderson
R. C. Henderson
J. W. Holcomb
H. D. Holdridge
W. T. Hopke
E. T. Howson
J. Hunciker
J. A. Hutchens
H. M. Jack
A. J. James
R. E. James
G. H. Jennings
C. H. Johnson
Maro Johnson
J. H. Johnston
Lee Jutton
A. E. Killam
A. H. King
C. R. Knowles
J. S. Lemond
C. A. Lichty
E. L. Loftin
P. K. Lutken
J. M. Mann
G. A. Manthey
A. S. Markley
E. M. McCabe
A. G. McKay
Neil McLean
A. McNab
E. S. Meloy
W. F. Meyers
J. D. Moen
A. Montzheimer
W. H. Moore
Homer Morgan
E. C. Morrison
J. R. Murray
P. J. O'Neill
J. F. Parker
S. F. Patterson
B. F. Pickering
D. E. Plank
Harry Pollard
G. W. Rear
R. H. Reid
A. W. Reynolds
M. Riney
J. S. Robinson
G. A. Rodman
D. Rounseville
Aug. Ruge
G. T. Sampson
F. E. Shanklin
J. B. Sheldon
W. Shropshire
C. E. Smith
C. U. Smith
M. A. Smith
Jos. Spencer
Wm. Spencer
J. M. Staten
G. H. Stewart
John Stewart
W. F. Strouse
W. M. Sweeney
D. B. Taylor
F. A. Taylor
J. J. Taylor
J. B. Teaford
M. E. Thomas
O. E. Ullery
C. F. Warcup
Chas. Wehlen
F. E. Weise
G. W. Welker
W. W. Wilson
J. L. Winter
J. P. Wood
C. W. Wright
E. C. Zinsmeister
D. C. Zook

The following applicants for membership, subsequently elected, were also present:—

T. H. Allen
A. B. Ashmore
T. R. Barger
E. J. Barry
F. A. Benz
C. W. Brown
F. J. Burgeois
A. C. Copland
Chas. Dale
R. F. Farlow
W. H. Fletcher
E. L. Goldsmith
Z. A. Green
W. I. Jackson
H. F. Jonas

L. E. Jones	O. R. McIlhenny	O. M. Sorrells
T. H. King	G. T. Richards	J. J. Steadham
G. A. Knapp	C. H. Shapleigh	Dr. H. von Schrenk
G. K. Nuss	J. S. Sharp	D. Zenor
E. C. Littlefield		

Total number of members registered, 154.

Ten past presidents were in attendance, viz.: J. P. Canty, L. D. Hadwen, A. E. Killam, J. S. Lemond, C. A. Lichty, A. S. Markley. A. Montzheimer, B. F. Pickering, R. H. Reid and J. B. Sheldon.

Charter members present: A. S. Markley and A. McNab.

Life members present: A. E. Killam, Neil McLean and S. F. Patterson.

The President:—We have a few reports that we want to take up before taking a recess. We will first have the secretary-treasurer's report.

C. A. Lichty:—F. E. Weise, the retiring treasurer at the end of the last fiscal year, submitted to the president and executive committee the following report last January, at the time that the funds were turned over to me:

Chicago, January 6, 1916.

Cash on hand Oct. 20, 1915, as reported at the Detroit convention,	$ 296.72
Interest,	4.45
Nine Windsor Golf Club Notes, $100 each, drawing 6 per cent interest,	900.00
Total turned over to the secretary-treasurer this date,	$1,201.17

REPORT OF THE SECRETARY-TREASURER.

Financial.

Receipts.

Sale of Badges,	$43.50	
Dues and fees,	1,240.00	
Advertising,	1,530.90	
Sale of books,	47.25	
From former Treas.,	1,201.17	
Interest,	27.00	$4,089.82

Disbursements.

Postage,	132.54
Printing and Engraving,	1,344.61
Stationery and Office Supplies,	33.90
Editing,	65.00
Drafting,	42.00
Stenographer,	105.00
Expenses of various committees,	39.09
Salaries and Office rent,	800.00

Detroit convention expenses, ...$	98.00	
Telegrams, express, and exchange, ...	9.21	
Miscellaneous, ...	17.00	$2,686.35
		1,403.47
Deficit from last year, ...		117.59
Amt. on hand Oct. 16, 1916, ...		$1,285.88

Balance due for advertising, $80.

C. A. Lichty,
Secy-treas.

The president announced the appointment of the following committees:—on resolutions, B. F. Pickering, Maro Johnson and E. T. Howson;—to audit the accounts of the secretary-treasurer, J. S. Robinson, R. H. Reid and J. D. Moen.

The President:—We will now receive the report of the committee on relief.

REPORT OF COMMITTEE ON RELIEF.

Joliet, Ill., Oct. 14, 1916.

The committee on relief wishes to report that during the past year no applications for relief have been received. It is a real pleasure to make a report of this kind, and indicates that the members of the Association are being very well taken care of.

Respectfully submitted:
Arthur Montzheimer,
Committee on Relief.

REPORT OF EXECUTIVE COMMITTEE.

A meeting of the executive committee was held at the Congress Hotel, Chicago, at 4: 30 p. m., March 22, 1916. The members of the committee present were: C. E. Smith, W. F. Strouse, F. E. Weise, C. R. Knowles, J. S. Robinson, J. P. Wood, S. F. Patterson and C. A. Lichty. Other members present included R. H. Reid, R. C. Sattley, A. S. Markley, J. H. Markley, Maro Johnson, Geo. W. Andrews, O. F. Dalstrom, L. D. Hadwen, J. B. Gaut, E. S. Meloy, A. McNab, C. H. Fake and M. Riney.

The committee appointed to audit the transfer of the accounts of the treasurer of the past year to the secretary-treasurer for the year 1915-16 made their report. The only other matter discussed was that pertaining to the selection of the hotel at New Orleans for the headquarters of the next convention. The committee on arrangements (C. R. Knowles, chairman) stated that the Hotel Grunewald was the best suited for the purpose, and that hotel was selected.

Several of the committees on regular subjects met after the meeting for the purpose of arranging to get out their reports.

A meeting was held at the Hotel Grunewald at New Orleans, Monday evening, Oct. 16 at 8 o'clock at which the following members were present: President Rear, C. E. Smith, W. F. Strouse, F. E. Weise, C. R. Knowles, J. P. Wood, J. S. Robinson, S. F. Patterson and C. A. Lichty. Others present included A. S. Markley, J. S. Lemond, R. H. Reid, B. F. Pickering, A. E. Killam, J. P. Canty, J. B. Sheldon, L. D. Hadwen, A. Montzheimer, E. T. Howson, E. L. Loftin, W. S. Corbin and Homer Pollard.

The committee on arrangements was called upon to give a tentative outline of the entertainment features. It was decided to hold the As-

sociation banquet Thursday evening. It was stated that there had been some talk of the combining of the Maintenance of Way Master Painters' Association with this association and the proposition was described by Mr. Howson. A motion was made to recommend to our association at its opening session that we make a proposition to said Painters' Association which was holding its annual meeting on the same dates in Philadelphia that it would be agreeable to consider the proposition of combining the two associations. The motion was carried.

The committee on arrangements was authorized to procure a lantern to be used for illustrating reports, lectures, etc., and to take the necessary steps in arranging for the association banquet. Meeting adjourned.

C. A. Lichty,
Secretary.

The President:—In looking over the early history of this association it would strike one that the event I am now going to announce has been somewhat neglected, and has been probably the weak point in this association's history,—that is the payment of dues. We find that the association is constantly carrying a large number of members somewhat behind. We will now have a recess for the payment of dues, and for the welcoming of new members.

(A recess was then taken until 2 o'clock p. m.)

AFTERNOON SESSION.

Tuesday, October 17, 1916.

The convention was called to order by the president at two o'clock.

The President:—The first business for this afternoon is action on the report of the committee on Membership and Election of New Members. It might be wise to follow the action of previous years and elect all of the applicants certified to by the membership committee during the convention, as there may be others coming in yet. If there is no objection to that method a motion to that effect will be in order.

It was moved and seconded that one ballot be taken for the election of the applicants for membership. The motion was carried unanimously.

REPORT OF COMMITTEE ON MEMBERSHIP.

The membership committee issued the following circular, which, with a small leaflet containing information, was sent out to prospective members:

Dear Sir:—

Are you acquainted with the objects and aims of the American Railway Bridge and Building Association?

This association was organized 25 years ago by practical bridge and building men, with the object of advancing knowledge pertaining to the profession. It provides a clearing house for the exchange of ideas and experiences and as such has proven of great value to its members and the railroads with which they are connected. It is to the bridge and

building department, what the American Railway Engineering Association, the Master Car Builders' Association, etc., are to the other departments, and its usefulness has been recognized and appreciated by the railroads.

The Association has about 700 members among whom are many high railway officers who have retained their membership after being advanced. It is felt that there are many others who are eligible to membership but who have not become associated with us, probably from lack of acquaintanceship. We are making an extra effort this year to reach all such, believing that increased membership will be of mutual advantage. The cost is nominal, $5 paying for membership and one year's dues, the annual dues being only $2.

You are cordially invited to become a member. If you will fill out the enclosed application blank and send it to the secretary, C. A. Lichty, 319 No. Waller Ave., Austin station, Chicago, your name will be placed before the members for election at the next annual convention to be held in New Orleans, October 17-19, 1916.

You are also welcome to attend any of our conventions whether you make application for membership or not, the meetings being open to all who are interested in the profession.

Very truly yours,
(Signed by the Committee).

The circulars brought good returns as will be evidenced by a glance at the list of applicants. Some difficulty is still experienced in reaching active bridge and building men on some roads owing to the fact that their names do not appear in the official lists. Many of the large systems are not represented in our organization. The committee would recommend the coöperation of the membership in reaching such eligible men.

The number of new members from the south is an evidence that it is a good plan to continue the change of location of the annual meeting from year to year as is being done at present. The committee desires to thank those who assisted in the securing of applications.

The following list of applicants eligible for membership is submitted for your consideration and their election to membership is recommended by the committee.

H. A. Horning,
G. A. Rodman,
B. F. Gehr,
W. S. Corbin,
J. P. Yates,
Committee.

LIST OF APPLICANTS FOR MEMBERSHIP.

Ailes, N. C., Asst. Val. Engr., D. & H. Co., Albany, N. Y.
Allen, T. H., Supv. B. & B., C. & O. Ry., Hinton, W. Va.
Ashmore, A. B., Supv. B. & B., M. L. & T. Co., Lafayette, La.
Barger, T. R., For. B. & B., L. & N. W. R. R., Homer, La.
Barry, E. J., Bldg. Insp., D. L. & W. R. R., Hoboken, N. J.
Benz, F. A., Div. Engr., B. R. & P. Ry., Rochester, N. Y.
Bourgeois, F. J., Supv. B. & B., N. O. G. N. R. R., Bogalusa, La.
Brown, C. W., Sou. Pac. Co., Mina, Nevada.
Clark, H. W., Supv. B. & B., Mo. Pac. Ry., Falls City, Neb.
Copland, A. C., Office Engr., C. & O. Ry., Richmond, Va.
Dale, Chas., For. W. S., I. C. R. R., New Orleans, La.
Farlow, R. F., Mast. Carp., B. & O. S. W. R. R., Chillicothe, O.
Faulkner, L. E., Ch. Engr., Miss. Cent. R. R., Hattiesburg, Miss.
Fletcher, W. H., Pensioned For. W. S., N. C. & St. L. R. R., 108 7th Ave., Nashville, Tenn.
Fullerton, J. H., Supv. B. & B., B. & M. R. R., Woodsville, N. H.
Goldsmith, E. L., Supt. Const., L. I. R. R., Jamaica, N. Y.

Green, Z. A., Pilot, Fed. Val., G. C. & S. F. Ry., Galveston, Tex.
Hancock, John, Engr., B. & B., U. Trac. Co. of Ind., Anderson, Ind.
Harrison, Chas., Gen. For. B. & B., M. O. & G. Ry., Muskogee, Okla.
Hawk, A. T., Archt., C. R. I. & P. Ry., Chicago.
Hicks, Wm. G., M. of W. Dept., L. I. R. R., Jamaica, N. Y.
Hodges, H. P., Asst. Engr. W. S., N. C. & St. L. Ry., Nashville, Tenn.
Hoffman, Geo. M., For. Ptr., P. & R. Ry., Shamokin, Pa.
Hotson, Wm. B., Supt. B. & B., E. J. & E. Ry., Joliet, Ill.
Irving, T. J., Asst. Engr. C. & N. W. Ry., Boone, Ia.
Jackson, E. A., For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Jackson, W. J., Div. Engr., C. & N. W. Ry., Winona, Minn.
Jonas, H. F., Engr. Struct., S. P. Lines, Tex. & La., Houston, Tex.
Jones, L. E., Asst. Engr., N. O. & N. E. R. R., New Orleans, La.
King, T. H., Supv. B. & B., L. & N. R. R., Knoxville, Tenn.
Knapp, G. A., Office Engr., G. C. & S. F. Ry., Galveston, Tex.
Kurokochi, S., Engineer, Imperial Govt. Rys., Tokyo, Japan.
Lattin, W. V., Supv. B. & B., N. Y. N. H. & H. R. R., Hartford, Conn.
Leach, W. A., Foreman, S. N. E. R. R., Providence, R. I.
Littlefield, E. C., Ch. Clk., N. Y. N. H. & H. R. R., New Haven, Conn.
Manley, B. F., Foreman B. & B., Pac. Elec. Ry., Los Angeles, Cal.
Marsh, M. M., Supt. Way & Brgs., Nor. Ry., Costa Rica, C. A.
McClure, J. C. E., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
McIlhenny, O. R., Asst. Supv., N. O. & N. E. R. R., Laurel, Miss.
McRostie, Roy, Asst. For. Const., O. S. L. R. R., Pocatello, Idaho.
Miller, C. E., Asst. Gen. Br. Insp., C. & N. W. Ry., Chicago.
Miller, M. D., Spl. Engr., C. R. I. & P. Ry., Chicago.
Murphy, R. E., For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Nelson, M. E., Engr. Brdgs., A. C. L. R. R., Wilmington, N. C.
Nuss, G. K., G. F. B. & B., D. M. & N. Ry., Proctor, Minn.
Oliver, W. H., Div. Engr., A. T. & S. F. Ry., San Bernardino, Cal.
Palmer, E. F., For. B. & B., B. & M. R. R., Salem, Mass.
Potter, A. K., Inspector, C. & N. W. Ry., Antigo, Wis.
Richards, G. T., Supt. B. & B. Shops, C. M. & St. P. Ry., Tomah, Wis.
Rohr, E. J., Asst. Br. Supv., C. & O. Ry., Brighton Sta., Cincinnati, O.
Runyon, C. C., For. B. & B., St. L. I. M. & S. Ry., Gorham, Ill.
Settle, T. H., Gen. For. B. & B., S. P. Co., Los Angeles, Cal.
Shapleigh, C. H., Asst. Engr., N. O. & N. E. R. R., New Orleans, La.
Sharp, J. S., Res. Engr., N. O. & N. E. R. R., New Orleans, La.
Shean, J. R., Ptr. For., Pac. Elec. Ry., Los Angeles, Cal.
Smith, A. W., Bridge Dept. C. N. Ry., Winnipeg, Manitoba.
Sorrels, O. M., Asst. Div. Engr., N. C. & St. L. Ry., Atlanta, Ga.
Steadham, J. J., Supv. B. & B., N. O. & N. E. R. R., New Orleans, La.
Sterling, W. M., Ch. Clerk, C. & N. W. Ry., Chicago.
Stiver, C. E., Scale Insp., B. & O. R. R., Garrett, Ind.
Thompson, F. J., Asst. Supv. B. & B., F. E. C. Ry., St. Augustine, Fla.
Todd, R. E., Asst. Engr., C. & N. W. Ry., Madison, Wis.
Turner, W. F., Asst. Div. Engr., Sou. Pac. Co., Ogden, Utah.
Vatter, E. J., For. P. & W., B. & M. R. R., Salem, Mass.
Von Schrenk, Hermann, Cons. Timber Engr., St. Louis, Mo.
Wells, C. R., Br. For., Sou. Pac. Co., Sacramento, Cal.
Zenor, D., For. B. & B., L. & A. Ry., Stamps, Ark.
Zorn, J. F., For. B. & B., Pac. Elec. Ry., Los Angeles, Cal.
Total number of new members, 68.

The President:—The next order of business is the consideration of subjects for report and discussion. The first report is on Subject No. 1, C. R. Knowles, chairman. Mr. Knowles will please come to the platform and read as much of the report as seems advisable.

Mr. Knowles read the first part of the report on Intakes and Intake Lines. After a lengthy discussion the second part on Internal Combustion Engines, was read by Mr. Knowles. (See report and discussion.)

The question of the proposed consolidation of the Maintenance of Way Master Painters' Association with this Association was presented for discussion. Several members described the informal discussions which had taken place between members of the two associations during the past year, looking towards the consolidation to combine the work of the two organizations, prevent duplication of activities and enable the members of the Painters' association to become connected with the stronger society. The following telegram was drafted and ordered sent to the Maintenance of Way Master Painters' Association, then in annual convention at Philadelphia:

New Orleans, Oct. 17, 1916.

F. C. Rieboldt,
Pres. M. of W. Master Painters' Assn.,
Hotel Walton, Philadelphia, Pa.

The American Railway Bridge and Building Association in session at Hotel Grunewald extends an invitation to the members of your association to join with it in the interest of more efficient maintenance of way work. We will accept all of your active members in good standing as members of this association without requiring membership fees. Other details to be perfected by a joint committee of three members from each association with power to act. Wire action taken.

Geo. W. Rear, President.

On the next day the following reply was received:

Philadelphia, Pa., Oct. 18, 1916.

Geo. W. Rear,
Pres. Am. Ry. B. & B. Assn.,
Hotel Grunewald, New Orleans.

Maintenance of Way Master Painters' Association appreciates your courtesy, but at the present time does not see its way clear to accept proposition.

F. C. Rieboldt, President.

The matter was therefore dropped.

Following a statement by the secretary, that some of the members were in arrears for dues for periods up to 4 or 5 years, several suggestions were made regarding the action which should be taken in such cases. The secretary stated that bills are mailed to delinquent members and that frequently those two or more years in arrears have paid in full. It was the consensus of opinion that those in arrears more than two years should not enjoy the privileges of the association unless the secretary be notified by members of their inability to pay dues, and proper action taken by the executive committee.

EVENING SESSION.

Tuesday, Oct. 17, 1916.

The evening session was devoted to the reading and discussion of reports on subjects (2) Floors for Engine Houses, Shops, Warehouses, etc. (D. Rounseville, chairman), and (6) Modern Methods of Driving Piles (Maro Johnson, chairman).

MORNING SESSION.

Wednesday, Oct. 18, 1916.

The meeting was called to order at 9: 15 with President Rear in the chair.

The President:—In accordance with the By-Laws the report of the nominating committee shall be taken up at the first session on Wednesday. We will now have the report of the committee on nominations.

The committee submitted the following report:

For President, C. E. Smith, St. Louis,

First V. Pres., E. B. Ashby, New York,

Second V. Pres., S. C. Tanner, Baltimore,

Third V. Pres., Lee Jutton, Madison, Wis.,

Fourth V. Pres., F. E. Weise, Chicago,

Secy-Treas., C. A. Lichty, Chicago,

Executive members, W. F. Strouse, C. R. Knowles, A. Ridgway, J. S. Robinson, J. P. Wood and D. C. Zook.

The President:—The report will be held over until tomorrow when the election will take place. The presentation of this report does not hinder anyone from making other nominations.

We will now take up Subject No. 4, Caring for and Handling Creosoted Material, of which committee E. T. Howson is chairman. The report was read by Mr. Howson. (See report and discussion.)

Upon the completion of the discussion of this Subject, C. R. Knowles, by the aid of the lantern, showed a number of illustrations of oil engines in connection with his report read the day previous.

Following this Mr. Weise read the report on Subject No. 8, Efficient Methods of Handling Work and Men. (See report.)

The secretary announced the receipt of a number of letters from some of the old members who were unable to be present, including W. M. Noon, W. A. McGonagle, Jas. Stannard, C. P. Austin, W. O. Eggleston, E. F. Wise, A. B. McVay, G. W. Andrews, F. E.

Schall, E. B. Ashby, Ed. Gagnon, J. N. Penwell, R. P. Mills, Frank Ingalls and others.

The report on Subject No. 9, Station Buildings for Passenger Service Only, was read by the secretary in the absence of the chairman, Mr. Long. (See report and discussion.)

Recess was declared until 2 p. m.

AFTERNOON SESSION.

Wednesday, Oct. 18, 1916.

Meeting called to order at 2: 15, by President Rear.

The President:—We will take up Subject No. 3, Paint and Its Application to Railway Structures. C. E. Smith reviewed the work of the committee and stated that a report had been prepared which would not be read, but would be printed in the proceedings. (See report.)

It was announced that the committees on subjects (5) Blank Forms for B. and B. Department Use and (7) Fireproofing Roofs of Wooden Buildings would not present any reports.

L. D. Hadwen, chairman of the committee on Subject No. 10, Economical Handling of Concrete on Smaller Jobs, presented this report. (See report and discussion.)

Lee Jutton, chairman of the committee on Subject No. 11, Small Coaling Stations read that report. (No discussion.)

The President:—This concludes the subjects for report and discussion. We will now have the report of the committee on subjects for next year,—F. E. Weise, chairman.

F. E. Weise:—The committee on Subjects has taken a few liberties this year and, instead of merely suggesting a list of subjects we have gone a little further into the matter of committee work. After we have gone over this we will be glad to have your criticisms or comments on what has been done and suggestions as to what the committee on subjects ought to do. You will remember that in years past the subjects for the next year were selected by a committee appointed the day before the convention closed which got together and made up a list for the next year in about five or ten minutes. A few years ago it was decided to appoint a committee on subjects a year in advance and give it a chance to make up a list. That has been the plan of the work for the last two years. We have gone a step farther this year and have taken up the subject of committee work.

You will notice that we have followed the practice that we started a few years ago,—specializing. Instead of taking a general subject, like "Paint," we take, "Painting of Frame Buildings" this year. Instead of having the general subject, "Blank Forms," we propose to limit it to water service records.

The President:—After such an invitation to criticise we ought to be able to go at him rather strong.

The Secretary:—The secretary desires to call your special attention to the work this committee has accomplished. Every member ought to read that report. It is one of the important branches of the work of an association of this kind. The committee is entitled to our most hearty thanks.

REPORT OF THE COMMITTEE ON SUBJECTS.

To the American Railway Bridge and Building Association in Convention Assembled at New Orleans, La., October 19, 1916.

Not long ago an interesting little article appeared in the daily papers. Someone looking through some old files in the United States patent office at Washington came across a letter written in 1838. The letter was from an employé of the patent office to the head of his department offering his resignation. He gave as his reason that in his estimation everything inventible had been invented and that the patent office would soon have to go out of business because there would be nothing to patent. Therefore he wished to pull out before the office was closed. The man who wrote the letter had never known of the telephone, telegraph or wireless telegraphy, the X-ray, the electric light and electric traction. The railway train and the ocean steamship had not been developed. He had not seen the wonders of modern photography and motion pictures.

The anecdote was intended to be humorous, but it is also pathetic. This man had no imagination and no faith in the future of his race. There is food for thought in the above. No man can foretell what the future will bring forth and the most optimistic imagination will fall far short of the reality.

The committee on subjects is called upon to exercise its imagination by selecting subjects that they expect and hope will prove of interest and value for the succeeding year. In looking through the back numbers of the proceedings we find first of all that practically the entire field has been well covered, and if we stop there we begin to feel that there is nothing more to report on. Shall we bring in a report that the work of the Association has been done and recommend that it disband? Such a proposition would surely meet with a chorus of emphatic "NO's." Why? Because our work has only begun. New methods are constantly being thought out and employed, and experience has shown that an exchange of knowledge and ideas brings about the most rapid progress.

This introduction is not an apology for the list of subjects selected for next year, but an explanation of the fact that the list has a very familiar appearance. Each time a subject is repeated we are surprised at the progress and development that is disclosed.

The greatest benefit which the members of the American Railway Bridge and Building Association derive from their membership is obtained from the committee reports. A committee report is a record of the best and most modern practice in its particular field, and contains facts,

opinions and suggestions that are of great assistance to the designer and constructor.

To be selected by the president as being competent to serve on a committee is no small compliment and the acceptance of such a position should be given serious consideration. The position carries with it certain responsibilities and extra work and in order that the best possible results may be obtained the work must be done conscientiously and thoroughly. The chairman of a committee usually realizes that a large measure of the work devolves upon him because he must take the initiative, outline the work and organize his forces. On the other hand committee members do not always acknowledge or appreciate their responsibilities and too frequently the chairman is forced to do the best he can and assume the burden himself. When committee members fail to co-operate, the report instead of being a committee report is the chairman's report and it is lacking in an essential quality, the joint opinion of several persons expressed after due deliberation.

Committee work may be handled in various ways and the method pursued must be governed by varying factors of which the following is a partial list—

a.—Location or residence of the members,
b.—Number of persons on the committee,
c.—Experience of the committee members in the subject,
d.—Interest taken by the committee members,
e.—Interest taken in the subject by members of the Association not on the committee who are called upon to contribute from their experience,
f.—Time allowed for collection of data and compilation of report.

It is very evident that no definite rule can be formulated. In the following we have endeavored to outline a plan that will offer some suggestions. We will assume that the members of the committee possess the necessary qualifications of experience, willingness and interest and that they are so located that committee meetings can be conveniently held. The chairman will first review the subject in a general way, analyze its scope and make an outline of its various subdivisions. This outline is then sent to the other committee members with a request that they review it and send comments, criticisms and suggestions to the chairman by a certain date. A committee meeting is then called for the purpose of a general discussion of the subject and to formulate a plan of work. In preparation for this meeting, committee members will make notes of the things they can contribute from their own experience and the names of persons who are likely to be in a position to furnish information. At the meeting a definite plan of work is decided upon. It is first determined whether the subject may best be handled as a whole or should be sub-divided so that each member may work independently on an allotment.

Many subjects require the collection of data showing the practice of different railways and the result and benefit of that practice, in order that comparisons may be made and conclusions arrived at. There is perhaps no better way to get this information than to compile a list of topics and questions and send it out in the form of a circular letter. The questions should be so worded that they will draw out statements of methods, opinions, comments or suggestions. Avoid as far as practicable questions that can be directly answered by "yes" or "no." If this is to be the method adopted, compile the list of topics or questions at this meeting and also decide upon the mailing list.

The members of our association have had a varied experience and each one has perhaps specialized in some particular line of work. For

this reason circular letters such as the above should not be sent to the entire membership but only to those who are in a position to make replies. The compilation of the mailing list is a matter of judgment. The secretary can be of considerable assistance in this because of his intimate personal acquaintance with so many of our members. If, on the other hand, the subject lends itself to subdivision, the work may be distributed among the several committee men, and each one should give the chairman assurance that he will undertake the work and endeavor to report at some definite time. The fixing of a definite date is important and brings about the best results. Our members are busy men and committee work must be done on spare time. If we work towards a definite date we all manage to get it done somehow.

The work of compiling the data collected and getting the report in shape must be very largely the work of one man. It usually falls upon the shoulders of the chairman but not necessarily. If there is a committee member who has talent in that line the chairman should not hesitate to press him into service. The completed report should be typewritten and a carbon copy sent to each member of the committee, and a second committee meeting called, at which it is gone over item by item, changes made as necessary and then it is sent to the secretary. All of the members should be at the second meeting in order that the report may be an expression of the committee as a whole.

The report is now passed upon by the publication committee, edited and sent to the printer. Advance copies should be in print before Oct. 1, in order that the secretary may make an announcement of it in his fall bulletin, thus enabling members to make requests for them and also allow the committee to send out some copies with a view of getting written discussions. This will give those who are interested in particular subjects but unable to attend the convention an opportunity to send in discussions by letter and in that way take part in the work of our association.

The plan as outlined above is rather an ideal one and will need modification to fit each particular case. The members of the committee may be so located that meetings are out of the question and all of the work must be handled by correspondence. In another instance all may be good at collecting data but lack time and facilities for compiling the report. Such a committee should confer with the secretary who with his usual resourcefulness and ability to master difficulties will find a way to take care of it.

Whatever the plan may be, enter into it with enthusiasm and energy. In this as well as all of our other undertakings, co-operation brings wonderful results and the success of committee work depends first upon the co-operation of the committee members and then upon the co-operation of the association. The statement has frequently been made, and will bear repetition here, that the active committee member profits most from committee work and this for the simple reason that the things we do ourselves are more deeply impressed upon us than the things we hear of and read about.

Every member of this association ought to welcome committee work, not only as a matter of duty, because he feels he ought to do his share in fulfilling the object of our organization, but also because it is a source of profit to himself and a pleasure as well.

The committee takes pleasure in submitting the following list of subjects for consideration during the year 1917 and recommends its adoption.

F. E. Weise,
J. B. Sheldon,
J. M. Staten,

Committee.

LIST OF SUBJECTS FOR NEXT YEAR.

1. Organization of the Water Service Department. Economical Delivery of Water to Locomotives.
2. The Construction of Shop Buildings.
3. Erection of Plate Girder Spans with the Least Interruption to Traffic.
4. Roof Drainage of Railway Buildings.
5. Repairing and Strengthening Old Masonry.
6. Hand Operated Devices for Lifting, Pulling and Hoisting.
7. Paint and Its Application to the Exterior of Railway Buildings.
8. Fireproofing Roofs of Railway Buildings.
9. Blank Forms for Water Service Records.
10. Snow Sheds. (A paper.)
11. Efficient Methods of Handling Work and Men.

The list of subjects was adopted.

The committee suggested that Subject No. 10 be presented in the form of a paper.

J. P. Wood:—What will be done with the subjects that were not reported on this year?

The Secretary:—They will be reported on next year.

C. E. Smith:—I think that when each member of the association knows what subjects are going to be assigned he can do good work if he will see if there is something that has come up in his experience that will be valuable in connection with that report. For example, in connection with shop buildings, probably some of you gentlemen have had unusual problems of this nature presented to you in the last year or two and in writing to the chairman of the committee you can give him valuable information on that subject. Doubtless some of you gentlemen have been called on to erect spans with the least interruption of traffic. You may be able to place before the committee much of value if you will go through the list. And the same thing may apply to every subject set down for next year.

W. E. Alexander:—The committee on "Subjects" seems to have left the bridge floor out at this time. This subject has been up but I don't think it has been finished. I think there is a chance yet for recommendations in bridge guards. I know of some cases that

call this to my mind that makes me think there really should be a different arrangement from what most roads have, and I believe, if something different could be applied, we might be benefited.

F. E. Weise:—In last year's proceedings there was a very elaborate report on pile and trestle bridges and guards were given thorough consideration in both the report and discussion. It might be as well to let it go over a year or more. I have made a memorandum of it for consideration.

The report of the auditing committee was then read by the secretary, as follows:

REPORT OF THE AUDITING COMMITTEE.

New Orleans, Oct. 18, 1916.

The committee appointed by the president to audit the books of the secretary-treasurer has examined the accounts and found them to be correct as shown in the report submitted to the association.

J. S. Robinson,
R. H. Reid,
J. D. Moen,
Committee.

On motion the report was adopted.

The report of the obituary committee was read by B. F. Pickering, as follows:

REPORT OF THE OBITUARY COMMITTEE.

New Orleans, La., Oct. 17, 1916.

To the American Railway Bridge and Building Association:

While the obituary committee profoundly regrets that it is necessary for it to report deaths in our membership, we must at the same time feel special gratitude to the great ruler and author of human life that, out of a membership of over 700 only one death has thus far been reported during the past year. However, in our gratitude and acknowledgment of this mercy, we cannot forget the household that has been stricken.

Therefore be it resolved that the sincere sympathy of this Association be and is hereby extended to the family of our deceased member and that we commend to them the loving-kindness and tender mercy of him who has been so merciful to our membership and who is ever the comforter and strength of the bereaved who trust in him.

Be it further resolved that a copy of these resolutions be inserted in our proceedings and a like copy sent to the family of the deceased member.

Respectfully submitted,
B. F. Pickering,
Committee.

The report was accepted.

The President:—We can possibly complete all of the work of this convention this afternoon except Dr. von Schrenk's lecture, the election of officers and the selection of the next meeting place.

The names of S. D. Bailey of the Michigan Central and Wm. Spencer of the Chicago and Northwestern, retired and pensioned by their respective roads, were placed in nomination for life membership.

Mr. Spencer declined the honor, stating that as long as he was able to attend the conventions he wished to be classed as an active member.

Upon investigation the secretary found (see page 33 of the 1915 proceedings) that Mr. Bailey was elected to life membership together with four others at the Detroit convention last year but his name was omitted from the last published list of life members.

Adjournment was taken at 5: 20 p. m. until 9: 30 a. m. Thursday.

MORNING SESSION.

Thursday, Oct. 19, 1916.

The convention was called to order by President Rear at 9: 30 a. m.

The first item of business taken up was the selection of the next meeting place. A. S. Markley placed the city of St. Paul in nomination; Washington, D. C., was nominated by J. Dupree, Cincinnati by C. R. Knowles, and Cleveland by R. H. Reid.

The first ballot resulted as follows: Washington, 15; Cleveland, 24; Cincinnati, 28, and St. Paul, 54.

In accordance with Section 2 of the By-Laws the city of Washington was dropped and another vote taken which resulted as follows: Cleveland, 29; Cincinnati, 32, and St. Paul, 71.

The President:—St. Paul has a majority of all the votes cast and that city will be our meeting place for next year.

(The selection of St. Paul as the next place for holding the convention was then made unanimous.)

It was announced that Dr. Hermann von Schrenk was present and would give an illustrated talk on the subject of Timber Used by Railroads.

Dr. von Schrenk was introduced by Mr. Howson. (Portion of lecture printed appears on page 37.)

ELECTION OF OFFICERS.

The President:—We are now prepared to receive any additional nominations beyond those made by the nominating committee.

On motion by Mr. Pickering, duly seconded and unanimously carried, the ballot of all the members present was thereupon cast by "Deacon" Patterson for all of the candidates nominated by the nominating committee as officers of the association for the ensuing term.

The President-elect was then escorted to the platform by C. A. Lichty and "Deacon" Patterson.

Retiring President Rear:—Mr. Smith, you have been elected to the presidency of this Association. Do you accept the office?

President-Elect Smith:—I do.

Retiring President Rear:—It is not customary for the retiring president of this association to make any lengthy speech. I will follow the usual practice, but before stepping down from office and turning the emblem of the same over to my successor, I want to say that during the past year I have done what I could for the interests of this association. If I have been successful at all I am very thankful to the members of the association. I thank all of you for the honor bestowed upon me when you elected me to this office one year ago, and in passing this emblem over to my successor I feel that I am passing it over to a man who will follow out the precepts of those who have preceded him, and will continue to advance the interests of this association. (Applause.)

President-Elect Smith:—I don't want to let this opportunity pass without thanking you for what I consider a very great honor. I consider it more of an honor for the reason that, perhaps, my training and my experience have been largely in a different school from that of most of you. I started in in what you gentlemen might call a theoretical school. Most of you have come up in the practical school. There is no difference between the two. All theory is based on practice, and all practice is based on theory, and no one has ever done anything in this world by theory that has not been based on practice. The time is not long past when engineers did not know how to figure stresses in bridges, and perhaps some of you older men remember the time, probably before I was born, when bridge men would go out and build bridges without plans, based on their judgment and on the things that they had learned at other

similar structures before. From those structures engineers who were familiar with mathematics, mechanics, etc., deduced certain laws. Some of those laws are as immutable as the stars, and others are empirical, based entirely on what has been done. We have had in recent years several examples of great failures that represent nothing whatever but the mistakes of theoretical men in trying to apply to practical work principles that did not apply.

I am reminded at this time of the steps that were taken by Mr. Eads in building the Eads Bridge across the Mississippi River at St. Louis. This comes to my mind because just recently the owners of that bridge asked me to make a valuation of it, and I went into the history of that bridge for them. In 1867 very little was known about such bridges, and very little was known about the action of such materials as he used; in fact, metal was just being used in such structures. Mr. Eads was a practical man, and he had enough of a practical head to know that he could not apply principles he learned in school and get results. Consequently he applied the test of practice to everything he did. Time after time during the construction of that bridge the whole work was stopped. He figured that certain things would happen; that he wanted certain steel to be used in certain places; but he had sufficient foresight to experiment with those things and try them out before he applied them to the work. In any number of cases his principles did not work out, and he was disappointed with his tests. At such times work on the bridge was stopped, sometimes six, nine, twelve months, until a series of tests were made so that he could determine what he could get; that accounts largely for the time taken in the construction of the bridge, about eight years. Mr. Eads knew that the construction of that bridge was a practical and not a theoretical matter.

To Mr. George Sampson, with whom I worked 20 years ago, and Mr. W. H. Moore and Mr. R. H. Reid, one of the hardest working bridge men in the country, and also a number of the men here who have spent a lot of time under me, I want to say it is a pleasure to be with you and other fellow members, and I feel deeply the honor you have conferred upon me (applause).

The other officers in turn were duly installed.

The President:—We will receive the report of the committee on resolutions.

(The report was presented by the chairman, B. F. Pickering.)

REPORT OF THE COMMITTEE ON RESOLUTIONS.

New Orleans, Oct. 20, 1916.

Resolved:—That the thanks of the Association be extended to the following individuals and corporations:

To Mr. Harold W. Newman, commissioner of public safety, for his address of welcome in behalf of the mayor and citizens of New Orleans:

To Mr. L. A. Downs, general superintendent of the Illinois Central, for his address in behalf of the railroads entering the city:

To the various railroads and the Pullman Company for favors granted our members and their families enroute to and from the convention, and especially to the Illinois Central, the Yazoo & Mississippi Valley, the Queen & Crescent, the Big Four, the Louisville & Nashville, the New Orleans & Northeastern and the New Orleans Great Northern for extra equipment and service:

To Mr. E. Ford and Mr. A. A. Woods and numerous other representatives of the railroads for the special efforts they put forth for the entertainment of our members and their guests:

To Mayor Sullivan and the citizens of Bogalusa and the Great Southern Lumber Company for courtesies shown and the entertainment of our members and guests while in Bogalusa:

To the manager, and his assistants, of the Hotel Grunewald for the courteous treatment of our members and their families and for the use of the convention hall:

To the members of the Committee on Arrangements for their untiring efforts in carrying out the details for the entertainment features:

To the Bridge and Building Supply Men's Association for its cooperation in providing entertainment for our members and their families:

The Association desires to express to Dr. Hermann von Schrenk its sincere thanks and appreciation for the able and interesting talk before our members assembled in convention, and takes this opportunity of placing this expression of appreciation on record.

To the press and the technical journals and their representatives for reporting our convention:

To the officers and the members of the various committees who so generously contributed their time and efforts during the year to make the work a success.

Respectfully submitted,

B. F. Pickering,
E. T. Howson,
Maro Johnson,
Committee.

Upon motion the convention adjourned to meet in St. Paul, Tuesday, Oct. 16, 1917.

Geo. W. Burgoyne,
Stenographer.

C. A. Lichty,
Secretary.

ENTERTAINMENT FEATURES.

The ladies were provided with tickets for the theatres during the time when our members were in session.

Wednesday evening our members and their guests were tendered a banquet and entertainment in the banquet hall of the Hotel Grunewald by the members of the Bridge and Building Supply Men's Association which was attended by about 360 in all.

Thursday afternoon the entire party was tendered an extensive auto ride about the city at the hands of the various railroads entering the city.

An association banquet took place in the banquet hall of the Hotel Grunewald Thursday evening, at which were present about 150 members and guests. Toastmaster Rear called upon a number of members for short talks, after which Mr. Wright of the Lehon Co. gave several impersonations.

F. E. Weise, with the aid of the lantern, presented a series of pictures taken on former convention trips after which two reels of motion pictures were presented showing the electrification of the Chicago, Milwaukee & St. Paul across the mountain ranges traversed by that line.

Friday an excursion to Bogalusa, La., and return was provided for the members and their guests by the New Orleans & Northeastern. Stops were made at the bridge over Lake Pontchartrain, the Southern Creosoting Works at Slidell and at Bogalusa where the party was conducted through and about the Southern Lumber Company's saw mill, one of the largest in the world. A complimentary luncheon was served at the Pine Tree Inn at Bogalusa by a committee headed by Mayor Sullivan, which, together with the remarks made by Mayor Sullivan and response by C. E. Smith made the affair one long to be remembered.

The Illinois Central provided an 11-car special train from Chicago to New Orleans with a four hour stop at Vicksburg. The Queen & Crescent and the Big Four ran three special cars for a party returning via Chattanooga and Cincinnati, and the Louisville & Nashville ran one car via Mammoth Cave with a stopover of one day for the accommodation of our members.

MEMOIRS.

MICHAEL FRANCIS CAHILL.

Michael Francis Cahill was born at Lynchburg, Va., on Oct. 28, 1852 and died at his residence in Jacksonville, Fla., on Dec. 4, 1915 after a sickness of only a few hours' duration. From early boyhood he manifested a keen interest in construction work and at the age of 20 he was engaged as a foreman on bridge work in Orange county, Virginia. Later he went west where he remained several years. Upon returning to Lynchburg he was employed with the Richmond & Allegheny railroad which was afterwards absorbed by the Chesapeake & Ohio. In 1892 he engaged in the contracting business in his home city, carrying out some large contracts in the south, among which were the erection of a standpipe at Key West and piping the city for its water supply.

From 1895 to 1899 Mr. Cahill was assistant superintendent of bridges and buildings on the Norfolk & Western and he served the Baltimore & Ohio in the same capacity from 1899 to 1901. In 1903 he went with the Seaboard Air Line as superintendent of construction, remaining with that road until 1911 when he again entered the contracting business in which he was engaged at the time of his death.

Mr. Cahill was married June 15, 1886, to Miss Margaret Morrison of Lynchburg, Va., who survives him together with a daughter Margaret and a son, Frank P. Cahill. A sister and two brothers reside at Roanoke, Va.

Mr. Cahill was sincere, honest and just. He was a friend to those in his employ, seeking to better their condition when possible. His genial disposition won for him many friends and in the community where he lived he was known as the "children's friend." As a citizen he was loyal and patriotic, always interested in movements having for their object the

betterment of political and civic conditions. At the time of his death he was chairman of the house committee of the Jacksonville lodge of Elks, a member of the chamber of commerce, the Ancient Order of Hibernians and the Sons of Confederate Veterans.

Mr. Cahill joined the Association in 1892 and was a devoted member. He was chairman of the committee of arrangements when the Association met in Jacksonville in 1909.

C. H. BISS.

Cyril Holm Biss was born at Dunedin, New Zealand, in 1866, and died at Christchurch, N. Z., July 24, 1914, after a short illness. Mr. Biss went to Auckland at an early age and received his education at the grammar school and at Auckland College. After passing the civil service examinations in 1884 he entered the engineering branch of the New Zealand railway department at Dunedin as a cadet. He was transferred to the headquarters staff at Wellington in 1887, and was subsequently appointed assistant engineer, in which capacity he gained experience of railway engineering in various parts of the Island.

"The late Mr. Biss," writes a friend, "was a most conscientious and painstaking official whose heart was thoroughly in his work. He was highly popular wherever he was known, and nowhere more so than in railway circles. He took the keenest interest in his work, and particularly in the scheme for the alteration and renovation of the railway buildings at Christchurch. He did not go in for sports and games very much, but his particular hobby was mechanics, and he had a very elaborately fitted-up workshop with a lathe and tools, and a good deal of his spare time was spent there."

Mr. Biss was a student of the Institute of Civil Engineers and was elected an associate member in 1892. After being appointed district engineer, he was stationed at Invercargill until the early part of 1897, when he was transferred to the Auckland district. In 1906 he was transferred to Christchurch as district engineer and was stationed there up to the time of his demise.

Mr. Biss joined the association in 1904 and kept constantly in touch with its proceedings, several times furnishing information for committee reports.

TIMBER FOR RAILROAD PURPOSES.*

(By Dr. Hermann von Schrenk.)

E. T. Howson:—Mr. President and Gentlemen: I think that we are unusually fortunate this morning in having an opportunity to listen to Dr. von Schrenk, who is going to speak to us on some of the common problems confronting the members of this association in handling timbers. With the exception of ties, practically all of the timbers used by the maintenance-of-way department of a railway are handled under the direction of the men forming this association. Dr. von Schrenk is known to all of us by reputation, if not personally, as a long-time student of this subject. I believe that he is the best posted man in this country on the practical phases of timber, its preservation and conservation. He is at the present time consulting engineer for ten large railway systems in the use of their timber. He is chairman of the timber committee of the American Society for Testing Materials; he is on a similar committee of the American Railway Engineering Association, and in addition to those activities he is conducting a careful investigation of a number of important problems at his laboratory in St. Louis. (Applause.)

Dr. Hermann von Schrenk:—Mr. President and Gentlemen: I want to say, first of all, that I appreciate very highly the cordial invitation that came to me to address you at this time.

The subject that I have been asked to talk about is so tremendous that any one would have to have his " nerve " to talk about it in the short time allotted to me. I will try to skim some of the high spots and indicate to you some of the problems confronting us in the utilization of timber in this country today. Before showing you the lantern slides I want to say a few words about the relationship of these things to the very broad economic problems that confront us in regard to timber, not only on the railroads but elsewhere.

Fortunately or unfortunately we have been a nation which has had raw materials for structural purposes in such tremendous abundance that we have taken the timber in its original form and used it in a lavish manner. We have been extremely wasteful of such materials and have had but very slight regard for the fundamental value of the material for the purposes for which we are using it. Timber has grown along the right of way, practically, or we have had to ship it only a few miles for use in our station buildings.

*Abstract of a talk delivered at the morning session October 19, illustrated with numerous lantern slides.

We have thought that if the supply diminished in a few years, there was much more where it came from. Many manufacturers said, "Oh, well, we are in the timber business; we want to sell some more timber." That peculiarly American sentiment of disregard of the value of material is very rapidly passing away. You have all heard of conservation of our resources. Personally, while I have very high regard for the fundamental truth of conservation, I believe very much more in its actual practice, because I feel very sure, that, as long as we have disrespect for the materials which we use, we will never be able to practice thoroughly any actual conservation of our own materials. If we don't respect the bridge stringer and get all there is out of it we are certainly not going to respect the pine tree, for its future use. Our good friends across the water practice more conservation than we.

The first slide that I will show you is illustrative of the European method. Some of them, coming over here with their notions, may mean that we should adopt their scheme of operation and construction. That, however, is not the meaning of the work we are doing. Where they beat us a mile is in their appreciation of every little piece of material that they are using, that it has a fundamental value and they are trying to find out how they can extend its service; in other words, how they can economize in the results they get. They beat us in the small things. If there is anything that we need badly in the timber game, it is to get a little closer to small details in our construction work; a little closer to knowing something of the weak and good points of every class of timber material that we use; find out why we don't get the service that we ought to, and remedy those difficulties as far as possible.

What I wish to say today is largely in connection with that subject. I wish, also, to emphasize the fact that the scare which we have had for years as to the exhaustion of our timber supply is ridiculous. I was amazed recently, when taking charge of one of our eastern systems, to find that every one of the two million ties used on that railroad had come from States which I had been taught had no more timber.

(Dr. von Schrenk then delivered his lecture, and explained the lantern slides shown in connection therewith.)

Dr. von Schrenk:—If you regard this as a vital factor in getting better service, in addition to using less material, you have the viewpoint of our European friend, and I am optimistic enough to be-

lieve that we are not only going to do what he is doing, but we are going him one better (applause).

The President:—I want to say that I am satisfied, after listening to the doctor, that he has been around some. I am also satisfied that he has the goods on us. I happen to hail from the Pacific Coast, and I have had the opportunity of wandering from one end of this country to the other, and I have seen the magnificent amount of timber on the Coast. I know that there are large quantities of timber on this continent that will keep us going forever, if we do not act like fools, as we have done in the past. With the adoption of modern methods and the care that he suggests, there is not the slightest doubt that there will be timber here as long as the world lasts. I feel that we should at this time give to the doctor a rising vote of thanks for the time that he has spent in coming here and delivering this address, which we have all enjoyed.

(On motion, unanimously carried, a rising vote of thanks was tendered Dr. von Schrenk.)

Subject No. 1

(a) INTAKES AND INTAKE LINES.
(b) FUELS FOR INTERNAL COMBUSTION ENGINES.

REPORT OF COMMITTEE.

INTAKES AND INTAKE LINES.

Properly speaking the word "intake" as applied to the pumping of water means the influx point of the pipe to the pump or well. Generally speaking, however, the term is used to designate any or all of the facilities utilized in delivering water to the pump, and it is in accordance with the general usage that the term is used here. The purpose of an intake in connection with a pumping station is to provide an uninterrupted supply of water to the pumps, and, if properly designed and constructed, it should prevent debris or rubbish carried by the water from entering the intake or the suction pipe and interfering with the operation of the pumps.

It follows that the proper construction and maintenance of intakes requires a careful consideration of the sources of supply and the character and quantity of matter carried by the water of running streams and a study of the prevailing currents and winds on lakes with a view to locating them at such points as will be less likely to be affected by adverse conditions. It is not always possible to locate an intake where conditions are favorable. The result is that it must be so constructed and protected as to overcome these difficulties as far as possible.

In considering the matter carried in water as affecting the operation of pumps a division may be made into two general classes; First, that having a specific gravity greater than water, such as mud, sand, gravel and cinders. And second, that having a specific gravity less than water, such as fish, leaves, small sticks and twigs, and vegetable matter. Certain classes of cinders also come under this classification. The first class may usually be taken care of by settling basins of proper design, while those in the second class require a strainer.

Any one or a combination of all the above troubles may be encountered, with slush ice, anchor ice and snow as important factors for trouble during the winter months in the northern states. An intake which will prevent trouble from one cause will probably be ineffectual with another. Rarely are two problems of this kind found to be alike, for, given the same quantity and character of debris or rubbish, the current velocity or direction of flow may exert different influences. However, there are certain phases of the transportation of debris by running streams that may be considered fairly uniform.

Transportation of Debris by Streams.

Extensive experiments were made at the University of California, under the direction of Grove Carl Gilbert of the United States Geological Survey, to determine the laws of transportation of debris by running water, which may be of interest in this discussion and extracts from this report are given as follows:

"In general, debris composed of particles of a single size is moved

less freely than debris containing particles of many sizes. If fine material be added to coarse, not only is the total load increased but a greater quantity of the coarse material is carried.

"Some particles of the bed load slide, many roll; the multitude make short skips or leaps, the process being called saltation. Saltation grades into suspension. When particles of many sizes are moved together the larger ones are rolled. When the conditions are such that the bed load is small, the bed is molded into hills, called dunes, which travel downstream. Their mode of advance is like that of eolian dunes, the current eroding their upstream faces and depositing the eroded material on the downstream faces. With any progressive change of conditions tending to increase the load, the dunes eventually disappear and

Multiple Strainer.

the debris surface becomes smooth. The smooth phase is in turn succeeded by a second rhythmic phase, in which a system of hills travel upstream. These are called antidunes and their movement is accomplished by erosion on the downstream face and deposition on the upstream face. Both rhythms of debris movement are initiated by rhythms of water movement.

"The bed of a natural stream which carries a large load of debris is composed of loose grains identical in character with those transported. The material of the load is derived from and returned to the bed, and the surface of the bed is molded by the current. When debris is transported through artificial channels, such as flumes and pipes, the bed is usually rigid and unyielding. Trifling as this difference appears it occasions a marked contrast in the quantitive laws of transportation, and in the laboratory the two kinds of transportation were the subjects of separate courses of experimentation.

"The flow of a stream is a complex process, involving interactions

which have thus far baffled mechanical analysis. Stream traction is not only a function of stream flow, but itself adds a complication. Some realization of the complexity may be achieved by considering briefly certain of the conditions which modify the capacity of a stream to transport debris along its bed. Width is a factor; a broad channel carries more than a narrow one. Velocity is a factor; the quantity of debris carried varies greatly for small changes in the velocity along the bed. Bed velocity is affected by slope and also by depth, increasing with each factor; and depth is affected by discharge and also by slope. If there is diversity of velocity from place to place over the bed, more debris is carried than if the average velocity everywhere prevails, and the greater the diversity the greater the carrying power of the stream. Size of transported particles is a factor, a greater weight of fine debris being carried than of coarse. The density of debris is a factor; a low specific gravity being favorable. The shape of particles affect traction, but the nature of this influence is not well understood. An important factor is found in form of channel, efficiency being affected by turns and curvature and also by the relation of depth to width. The friction between current and banks is a factor and therefore likewise the nature of the banks. So, too, is the viscosity of the water, a property varying with temperature and also with impurities, whether dissolved or suspended."

From the foregoing it will be seen that the transportation of debris in running water is such a complex process that each particular case presents a problem to be considered on its merits, taking into consideration width of channel, velocity of stream, slope, depth, density and size

of debris and viscosity of water. When the conditions are such that the load forms dunes or bars there is no intake that will prevent stoppage of intake pipes, unless the water is taken high enough above the bed to prevent the intake pipe coming in contact with the dunes as the dune or bar is likely to form during flood periods and either cause the pipe to be choked or the intake may become completely covered. The formation of these dunes or bars may even change the course of the stream and very often the course of the channel.

It is obvious that where such matter is carried in the water that may leave a heavy deposit causing dunes to form, the intake must be located where the dunes are not likely to form or that other precautions be taken to prevent the dunes forming at the point of intake.

Twin Strainer With Multiple Basket.

Intake Sumps and Wells.

Where the bed of the stream and the bed load is composed of coarse sand and gravel with but little silt or mud a fine strainer such as a well screen may be buried in the stream with good results. Where silt, mud and fine sand are carried in the water it is necessary to provide the well or sump with two or more compartments where the water may be brought to rest and the heavy matter allowed to settle. A two-compartment sump of this type is shown in Fig. 1. The water enters the first compartment through a 14-in. intake line from the stream. As this compartment has an area of approximately 50 sq. ft. the water comes to a rest before passing into the second compartment, depositing a large part of the matter in suspension. This deposit consists chiefly of sand and heavy silt as when the pumps are working the water does not remain in the sump long enough to permit of the finer particles of mud and silt settling to the bottom. The water passes to the second compartment through two 14-in. openings, screened with ¼-in. mesh screens, which

keep back all floating matter so that no debris is allowed to enter the pumps. The intake pipe from the stream is provided with a gate valve which may be closed while cleaning the sump. An opening is provided with a cast iron frame and cover in the top of the sump for cleaning.

A sump of this type was completely covered with water for nearly a year without any interruption to the water supply. When cleaned it was found to contain about eight cubic yards of mud, sand, leaves and hulls from hickory nuts. The deposit was nearly 4 ft. deep on the intake side and about 10 in. deep on the suction side.

Single Strainer.

Strainers and Foot Valves.

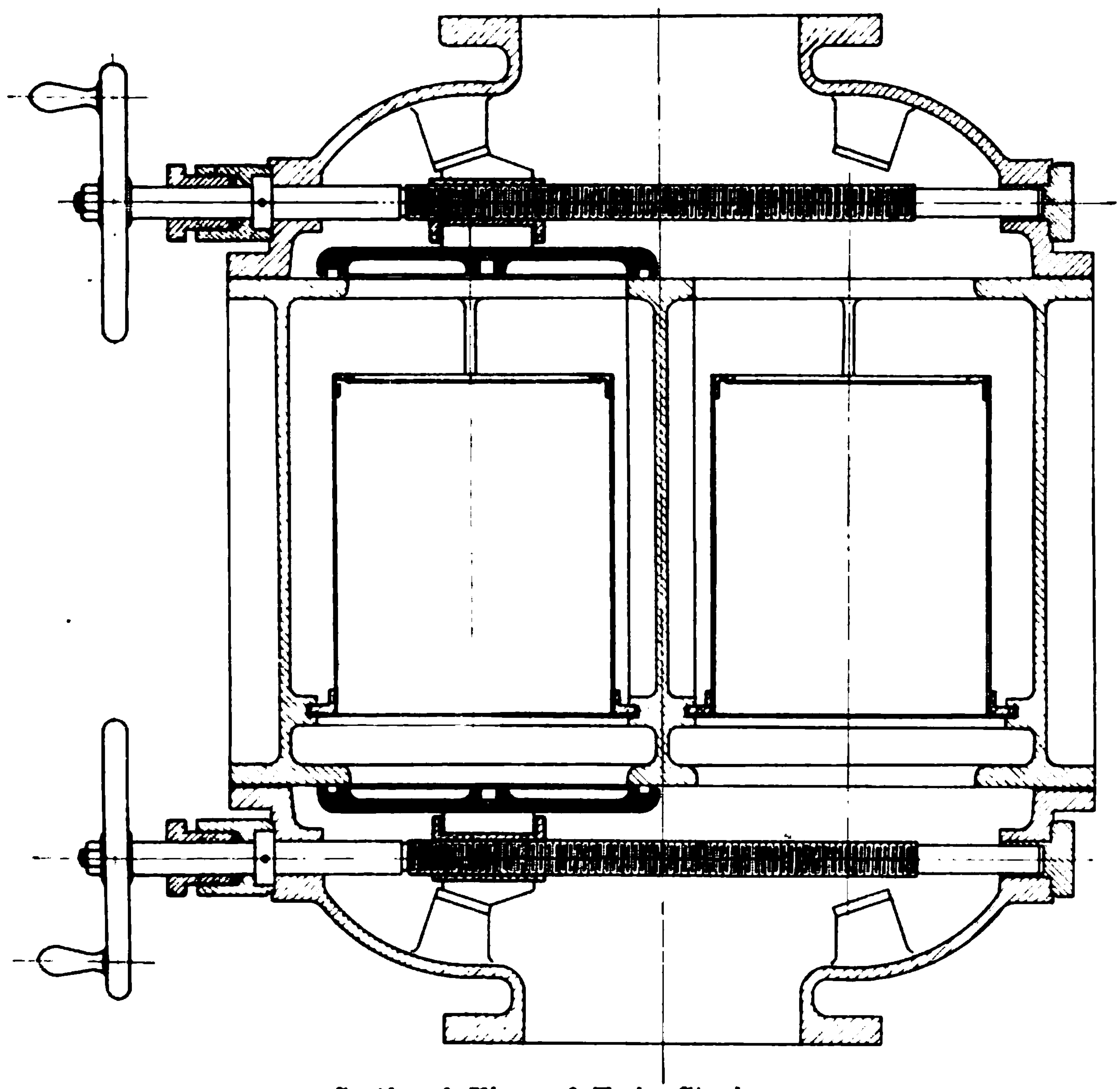
Where the water is clear and there is but little debris a foot valve with strainer will answer the purpose, always providing the foot valve is readily accessible and of ample area both as to straining area and for the passage of water. The straining area of a foot valve should be at least three times the displacement of the pump and preferably more, as with insufficient straining area the velocity of the water through the strainer is increased, the debris accumulates more rapidly and it will in time either completely cover the strainer or close up the openings to such an extent that the pump will not receive sufficient water to fill the cylinders. With a large straining area the velocity of the water is not so great and there is less tendency for the rubbish to accumulate on the strainer. These foot valves are of all types and kinds, varying from the ordinary flap valve to the larger valves with multiple valves and seats, arranged as in the valve deck of a pump.

On some intakes it is the practice to use screens of large area and

Multiple Strainer with Right Hand Basket Raised for Cleaning.

Sectional View of Multiple Strainer, Showing Basket in Position.

varying mesh according to the size of the matter in the water, placing these screens beyond the mouth of the intake pipe. Various arrangements of these screens are employed for removing the foreign matter from the water, but the method usually adopted is to have the screen so arranged that a clean one may be inserted behind the dirty one, so that the dirty screen may be removed for cleaning. Where the water contains large quantities of leaves or other floating matter the screens clog up very rapidly and require frequent cleaning. It is therefore very essential that they be readily accessible and they can not be used where the height of water varies greatly or other conditions prevent ready access to them.



Sectional View of Twin Strainer.

Where no foot valve is used the end of the suction pipe is sometimes plugged and perforated for several feet, thus forming a strainer. This method permits turning the pressure back from the tank where a by-pass is provided and flushing out the strainer. This is not desirable, however, where there is much foreign matter in the water as it interrupts the operation of the pumps and wastes a great deal of water.

Where the water is taken direct from the source of supply without any intake sump the "twin" or "multiple" strainer is undoubtedly more effective than any other type. As the name would imply these strainers consist of two or more compartments, any one of which may be cut out of service and cleaned without shutting down the pump. A 10-in. strainer of this type has been in use in a railroad pumping station in

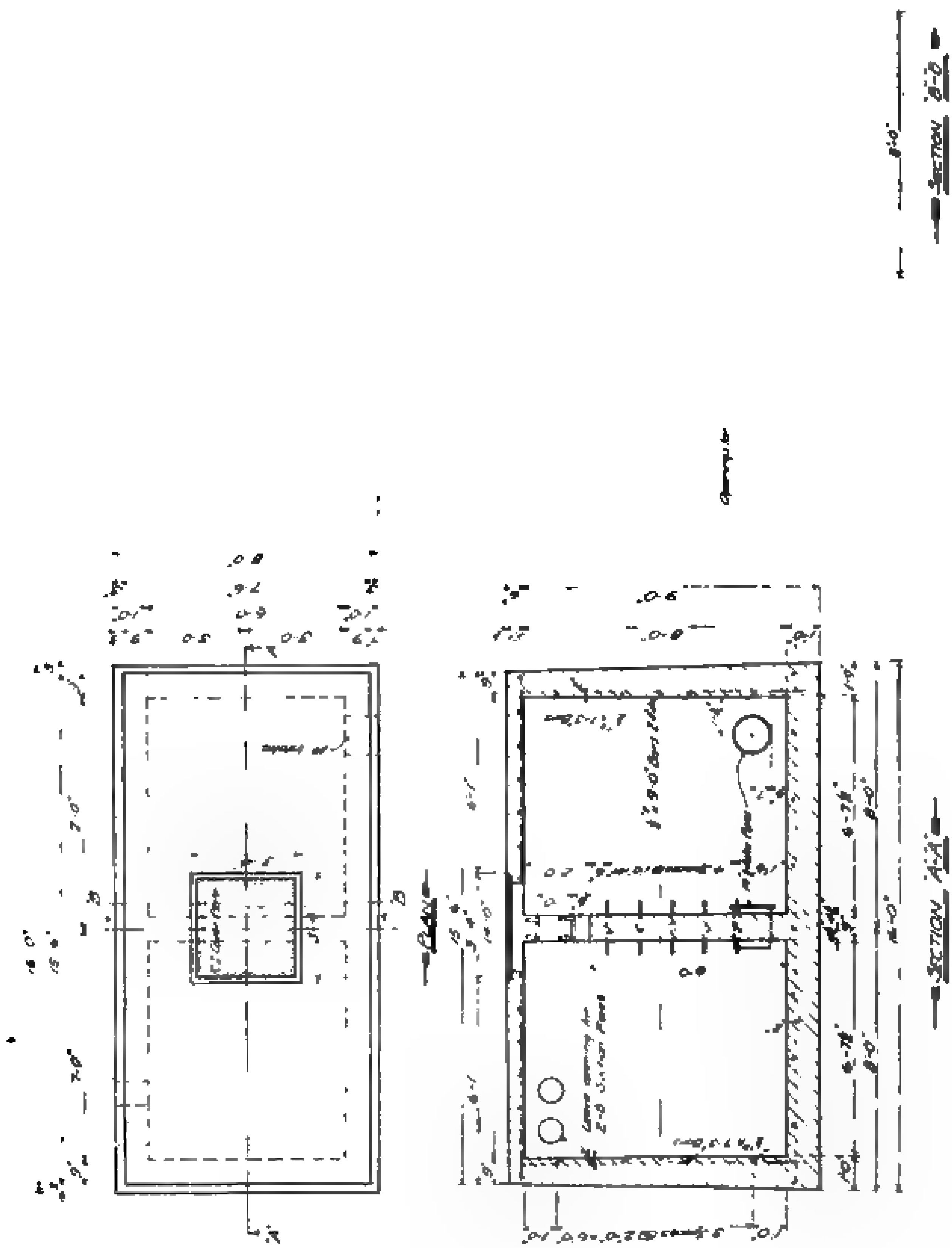


Fig. 1. Standard Intake Sump, Illinois Central R. R.

Chicago, pumping from Lake Michigan for a period of seven years. There have been times when this strainer has been cleaned at intervals of 20 min. for 10 hr. at a time without shutting down the pumps. This type of strainer is usually located in the pump house at a point near the pump for convenience, but may be located anywhere in the suction line.

Lake Intakes.

A common trouble with lake intakes and sometimes with northern rivers is the formation of anchor ice in needles and in thin flakes. This anchor ice usually forms in moving water, and is carried below the surface by currents where it adheres to the intake, forming a heavy mass that soon shuts out the water and is very difficult to remove. Steam jets

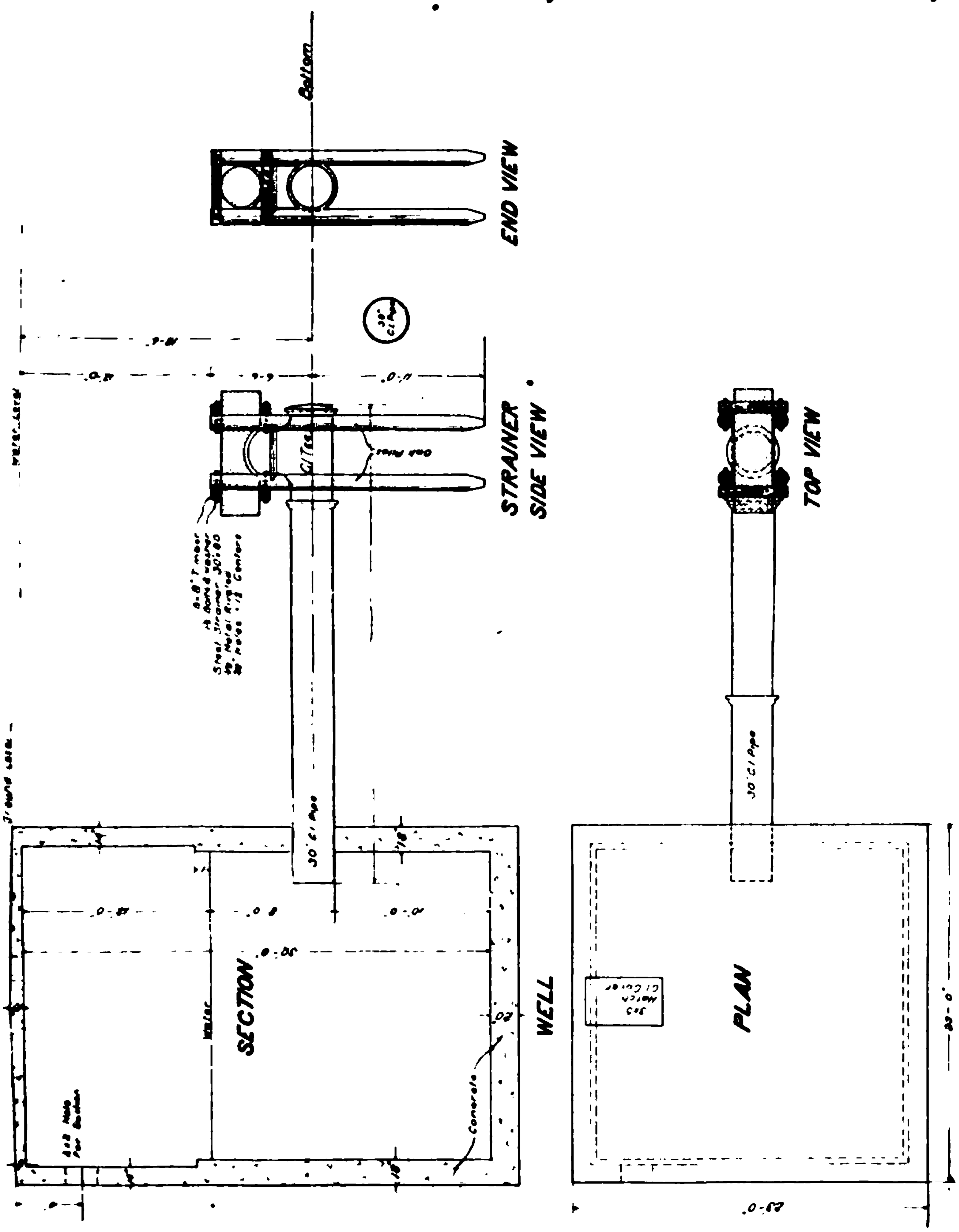
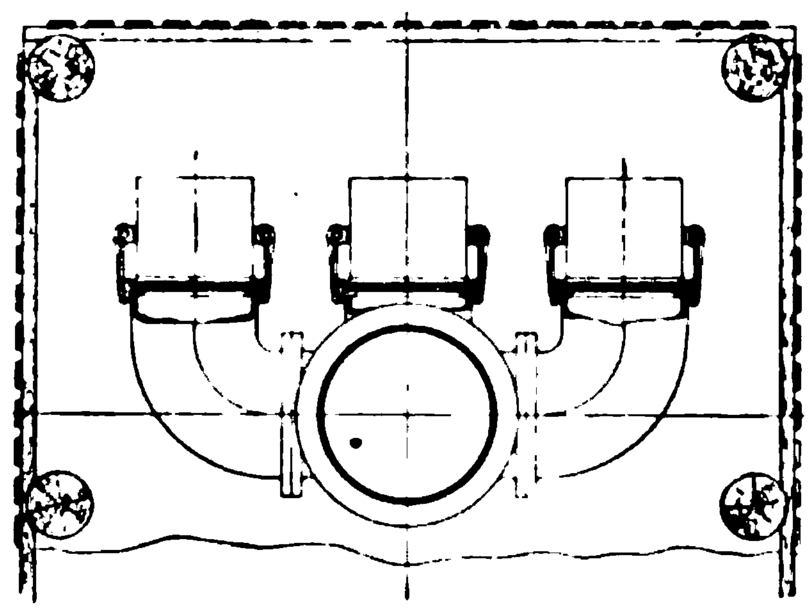


Fig. 2. Lake Intake, Illinois Central R. R.

are sometimes used to keep anchor ice away, but the most effective methods of guarding intakes from this defect is to either locate the intake in quiet water or to create a zone of quiet water by driving piling.

Fig. 2 shows an intake designed for a railroad pumping station located on Lake Michigan. As the plan indicates the intake strainer is located 1,150 ft. from shore, though this distance may vary according to local conditions. The water flows to the intake well through 30-in. Class "A" cast iron pipe. In this particular instance a 30-in. intake pipe was larger than actually required, but as a pipe of this diameter is buoyant enough to float, while a smaller pipe requires lighters to float it into position, it was found that the 30-in. pipe could be laid for approximately the same expense as a smaller pipe. The bed of the lake was dredged for the pipe to secure a uniform bearing and the pipe laid on the bottom. It was put together several sections at a time, floated into position and the joints made under water by a diver.



Arrangement of Crib for Removable Strainer—3 Baskets.

Suction Lift.

Suction consists of creating as nearly as possible a perfect vacuum in the suction pipe in order that it may be filled with water by atmospheric pressure. Thus a suction pump must act as an air pump, creating a vacuum in the suction pipe when priming itself. As the permissible suction head is confined within comparatively narrow limits the pump should be located as near the source of supply as possible to avoid undue suction losses. The suction lift is governed by the atmospheric pressure. At sea-level the atmospheric pressure is 14.7 lb. per sq. in., which is equivalent to a height of water barometer or a perfect vacuum of 34 ft. or 30 in. measured on a mercury barometer. This height decreases as the altitude increases. Thus at an elevation of 2,000 ft. above sea-level the atmospheric pressure is 13.7 lb. and the height of a perfect vacuum 31.6 ft. The total suction head will never equal the height of a perfect vacuum, as certain suction losses can not be avoided, such as the influx loss at the end of a suction pipe and friction and velocity losses. Also the temperature of the water must be considered although this exerts but little influence when the temperature is under 100 deg., the suction loss with water at 100 deg. being 2.2 ft.

Altitude tables necessarily vary owing to atmospheric influences, but the above table will be found accurate enough for ordinary purposes.

While in common practice a suction lift of 24 to 26 ft. is sometimes possible a pump should rarely be placed more than 20 ft. above the lowest water and wherever practical just as close to the water as possible.

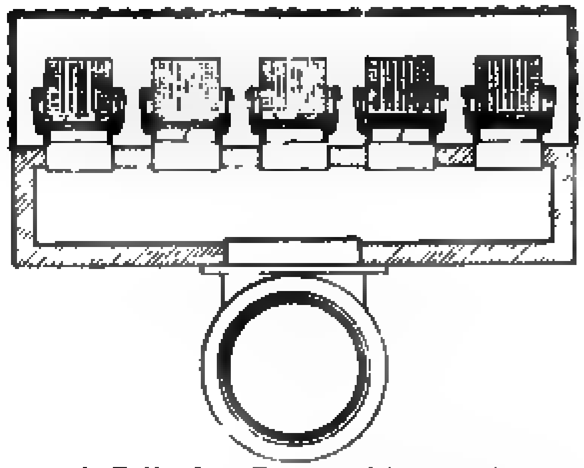
Altitudes and Normal Atmospheric Pressure at Various Points.

Location	Elev. above Sea Level.	Atmospheric Pressure in lb. per sq. in.	Height of Perfect Vacuum in Feet.
Pike's Peak, Col.,	14,108	8.60	19.86
Leadville, "	10,190	9.98	23.05
Cheyenne, Wyo.,	6,000	11.72	27.07
Denver, Col.,	5,279	12.04	27.81
Pueblo, "	4,660	12.33	28.48
Helena, Mont.,	4,000	12.65	29.22
Missoula, "	3,200	13.00	30.09
Spokane,	1,900	13.70	31.64
St. Cloud, Minn.,	1,020	14.17	32.72
Atlanta, Ga.	1,000	14.18	32.74
Chattanooga, Tenn.,	674	14.36	33.17
Cleveland, O.,	642	14.38	33.21
Chicago, Ill.,	600	14.40	33.26
Cincinnati, O.,	500	14.46	33.34

Suction Lines.

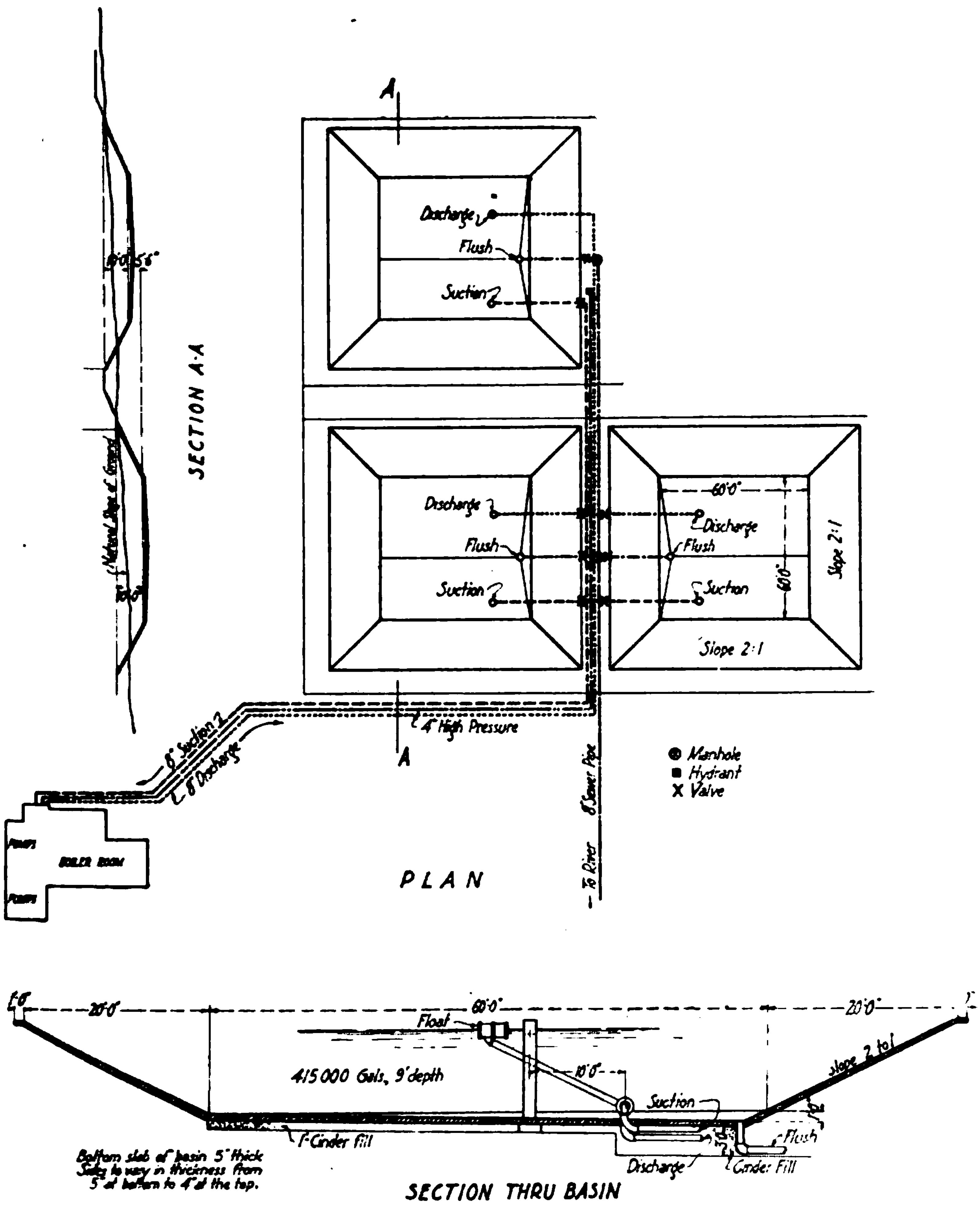
Suction pipes should be made as short and direct as possible, avoiding all unnecessary bends or elbows. The size of the suction pipe will be controlled to a large extent by the permissible loss of suction head. If the suction line is of any considerable length it will be necessary to increase the size of the pipe to cut down the velocity and reduce the friction loss. In any event a suction line longer than 50 ft. or with more than two elbows should be at least one size larger than called for by the maximum delivery of the pump. Long suction lines and those with high lifts should be provided with vacuum chambers to take up the irregularities of flow due to the action of the pump. Suction lines are subject to more or less vibration owing to the action of the pump and the importance of keeping such lines tight necessitates the use of threaded or flanged pipe. Cast iron pipe with lead joints is sometimes used for suction lines, but the difficulty of keeping lead joints tight should limit the use of cast iron hub and spigot pipe to only such conditions where excessive corrosion occurs. Under ordinary circumstances a bolted or threaded joint is to be preferred. While a suction line in many instances forms the most important feature of a railroad pumping plant, too often it receives the least attention with the result that the efficiency of the pumping unit is greatly reduced and the cost of maintenance increased through a faulty suction line. Too much importance can not be laid upon the suction line. First the pipe should be of first class material, preferably of genuine wrought iron pipe. Steel pipe put into the ground for a sewer or drain would only be expected to last a few years, but if placed in a suction line it is usually tacitly assumed that it will last indefinitely. Many suction lines show conclusively upon examination that deterioration and decay often occur after only a few years' service. No definite prediction can be made of the life of a suction line, the rate of deterioration depending upon special conditions.

The consumption of water on railroads has increased to such an extent in the past few years as to completely revolutionize the methods of handling the water supply, the intakes and intake lines being by no means the least important problems involved. No treatise, however voluminous it might be, can meet or suggest remedies for all difficulties encountered in this connection.

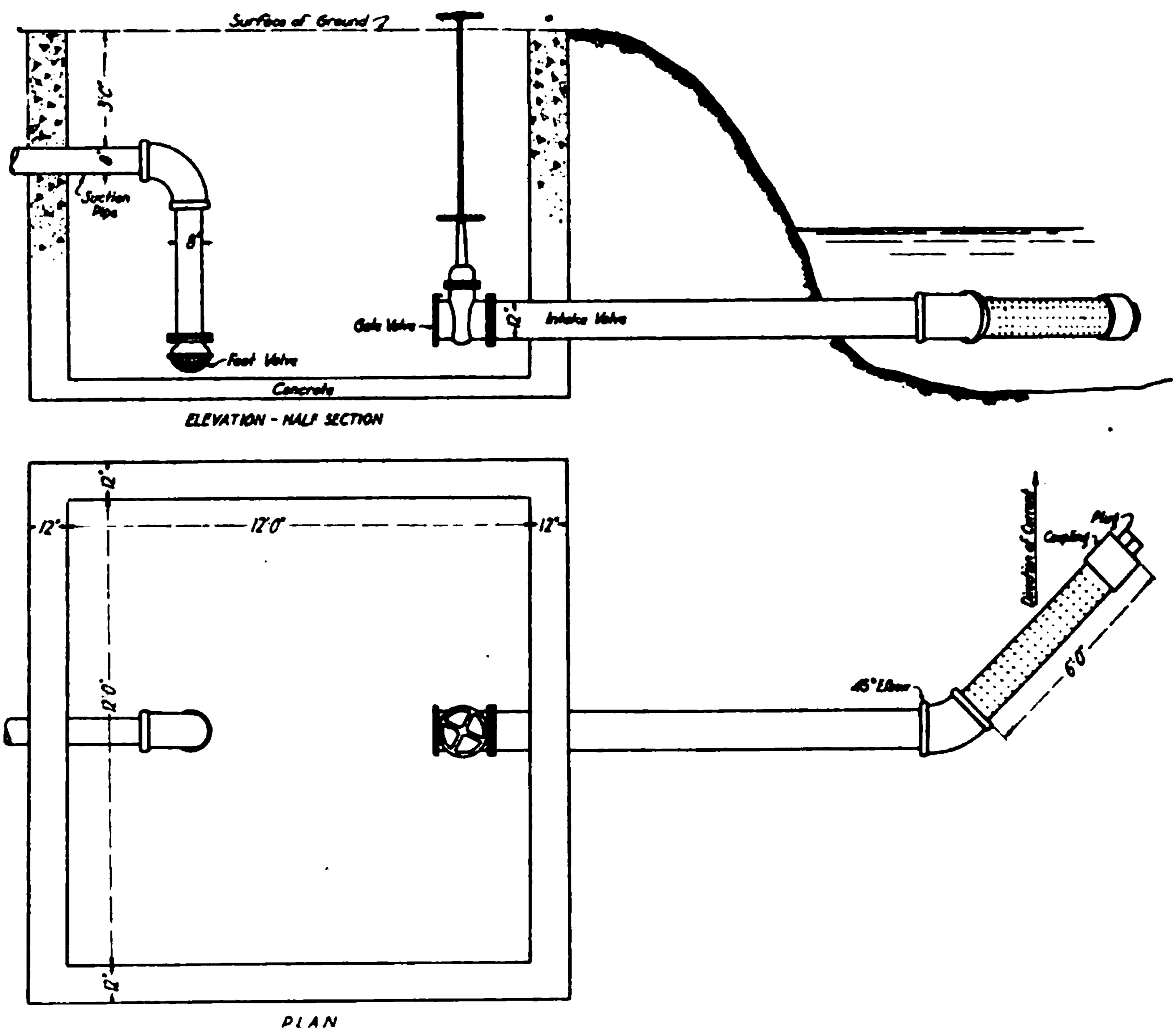


Arrangement of Crib for Removable Strainer—5 Baskets.

Intake Strainer Arranged for Cleaning.



Settling Basin Near Mobridge, So. Dak., Chicago, Milwaukee & St. Paul Ry.



Intake From Stream, Terre Haute & Southeastern Ry.

FUELS FOR INTERNAL COMBUSTION ENGINES.

While the title of this report suggests all fuels used in internal combustion engines, neither time nor space will permit of an intelligent discussion of all fuels suitable for this purpose. The intent is to discuss only the oil fuels, particularly the heavy petroleum oils.

Three distinct grades of engine-burning oil have been developed from the crude, which are designated as light, medium and heavy distillates. The following table gives the products of the crude oil of interest in connection with oil engines:

Light Distillates	Medium Distillates	Residues
Light benzine	Kerosene	Cylinder oil
Gasoline	Solar oil	Engine oil
Heavy benzine	Gas oil	Pitch and asphalt

The light distillates in the above table are suitable for the gasoline engine and may be burned readily through a carburetor or mixing valve. Kerosene and distillates of 39 deg. Baume and over with a flash point of 230 deg. and under, and a burning point of 280 deg. and under may be burned readily in a gasoline engine equipped with a generator for preheating the oil before it enters the cylinder. The remaining distillates of 26 deg. Baume and over may be burned readily in the hot-bulb type of oil engine. It may be mentioned that the specific gravity is of minor importance, but a certain limit of low specific gravity is necessary in order to get the oil through the spray and lift pumps.

The main points in purchasing fuel oil for internal combustion engines are as follows:

There should be only a trace of earthy matter, such as dirt, etc., in the oil, and not more than one per cent of water. Of coke residue there should not be more than a trace, as any appreciable amount will cause trouble in the plugging of the cylinders. There should not be more than a trace of free carbon in the oil. The sulphur content should not be more than 0.8 per cent, as a greater proportion may attack the cylinder walls and tend to cause pitting. The oil should contain no free ammonia, alkalies or mineral acids because of their pitting effect on the surfaces exposed to combustion. The oil should not contain more than 0.05 per cent of non-combustible mineral matter. A paraffin content of more than 15 per cent may cause trouble as a large quantity of oxygen is necessary for complete combustion. The oil should contain not less than 10 per cent hydrogen and should have a heating value of about 18,000 B. T. U. per pound. The tar content should not exceed 0.4 per cent. Oil containing creosote will cause incomplete combustion and give trouble by coking.

The following extracts taken from Technical Paper, No. 37, Department of the Interior, Bureau of Mines, are of particular interest in the study of fuel oil and indicate the variety of oils available as fuel for heavy oil engines:

On the Pacific and Gulf coasts of the United States, not to consider the increasing output in Mexico, there is produced a great quantity of heavy asphaltum oils. These may be refined and first-class products manufactured therefrom. In this refining, as also in the refining of the petroleums from the other oil fields of the United States, there is produced a so-called gas oil which is that portion of the petroleum distilling between the heavy naphthas or kerosenes and the light spindle oils. It is too heavy for lamp oils or for burning in a gasoline engine, and is too light for lubricants. The United States Geological Survey states that there was produced in 1911 from the California and Gulf coast oil fields 101,381,285 barrels of crude petroleum, valued at $50,942,446. This petroleum on refining would have yielded approximately 5 per cent, or 5,069,064 barrels of gas oil. From the other oil fields of the United States in

1911 there was produced 119,068,106 barrels of crude petroleum, valued at $83,102,306, of which approximately 3 per cent, or 3,572,043 barrels was gas oil, making a total of 8,641,107 barrels of gas oil.

By being mixed or blended with a small proportion of the low-boiling natural gasoline gas oil can be enlivened, by increasing its volatility and lowering its specific gravity and flash point, and made to burn in explosion engines.

A study of the use of gas oil in this engine has naturally led to the study of other similar oils, and the fact has been developed that there are being produced in greater and greater quantities in the United States coal tars and tar oils from gas works and coke plants. There were produced in the United States in 1909, 60,126,006 gal. of coal tar valued at $1,408,611 and 92,152,938 gal. of gas tars, valued at $1,875,549. The production has been materially increased since that time.

In California, North Dakota, Oregon and Texas there was produced in 1910, 1,555,068 tons of lignite, valued at $2,907,977. In North Dakota, where lignite mining is best developed, considerable work has been done on the manufacture of gas and briquets from lignite. It seems, however, that little consideration has been given to the subject of tar and by-product manufacture. This should be given first consideration if one looks to the best conservation of the raw lignite.

These tar oils burn successfully in the heavy-oil engine, and are therefore an additional and very important source of power. The coal tar and lignite industries have been developed to a high degree of efficiency in Europe, where they are decidedly profitable, and there is no reason why they should not be made profitable in the United States as well.

In working up wood wastes, wood tars and tar oils that can be used in the heavy-oil engine are being produced by distillation in increasing quantities. In 1909 there were produced in the United States 361,221 gal. of wood oils and 1,364,984 gal. of tars, the total value of which was $177,833. The production must have been materially larger in 1912. The waste wood of our forests offers a profitable source for liquid fuels, and the demand for and the consequent production of other wood by-products, such as creosotes, alcohols, etc., will increase with the growth of these industries.

The seed and animal oils can be used as liquid fuels in an emergency, burning well in heavy-oil engines, but because of their greater value for other uses in the industries they are not at present a factor as liquid fuel.

The alcohols burn successfully in heavy-oil engines when mixed in the proportion of 80 parts of alcohol with 20 parts of benzine. The wood alcohols, by-products of destructive distillation of waste woods, and also alcohols prepared as products of fermentation from grains and other carbonaceous materials, as waste cornstalks, grain stalks, etc., offer a most promising field as a source of fuel for these engines whenever such products from these waste materials are produced in greater quantities than can be used economically in other ways, and when in an emergency a demand for liquid fuel becomes imperative.

Outlook for Suitable Fuel.

These great sources of liquid fuels open practically an unlimited supply for heavy-oil engines, and the future for these engines in this country is very promising. It would be to our material advantage to manufacture from our bituminous coals, woods, and oil residues the gases, tars, cokes and the many other by-products, and to use these in their proper places in the industries rather than to burn the crude materials wastefully, as at present, directly under steam boilers for power generation. This would not make oil a competitor to the disadvantage of coal, but would increase the usefulness of coal by developing its pos-

sible by-products and thereby increase the value of the raw coal itself.

As approximately 0.4 lb. of an oil similar to gas oil will produce 1 horsepower-hour when burned in a heavy-oil engine, the total production of gas oil from the petroleum fields for 1911 would alone, without considering the vast resources of coal and wood oils, develop approximately 6,351,213,645 horsepower-hours without in any way interfering with the uses of the other petroleum products now manufactured. This would mean the addition of about 725,000 horsepower running continuously throughout the year.

Advantages in Storage.

Oil if stored in closed tanks, unlike coal does not deteriorate when standing nor is it subject to spontaneous combustion; but the greatest care should be given to its storage, as oil and its vapors are very searching and extreme precautions are advisable, though with proper ventilation of the tanks the danger from fire is nil.

Weight for weight, oil can be stored in a smaller space than coal. One ton or 2,000 lb. of bituminous steaming coal occupies approximately 40 cu. ft., according to A. H. Fay, mining engineer, Bureau of Mines, whereas a ton of oil occupies approximately 35 cu. ft. The relative storage value of coal as compared with oil is therefore 10 to 11.5.

A good steaming coal develops, according to A. C. Fieldner, chemist, Bureau of Mines, approximately 7,500 calories per gram. An average fuel oil develops approximately 10,500 calories. The relative calorific value, per unit weight, of coal as compared with oil is therefore approximately 10 to 14. For marine steam production, therefore, considering storage capacity, the relative value of coal to oil is 10 to 16.1, although the United States Navy gives a ratio even greater.

The relative efficiency of the steam engine compared with the heavy-oil internal-combustion engine is conservatively 10 to 25. Or, for marine service, the ratio of the total power of a heavy-oil internal-combustion engine for marine propulsion to that of a coal steam engine, considering fuel storage, calorific value of fuel, and engine efficiency, is approximately 10 to 40.25.

Combustion of the Fuel.

In selecting a fuel for this engine its composition as affecting combustion is most important. For proper combustion the fuel should be mobile and volatile, clean, and free from water, solid particles and grit. In general the specific gravity of an oil rises directly as the vapor density. The boiling point and the amount of air necessary for combustion vary inversely with the volatility, and the greater the volatility of the fuel the better the ignition and combustion. The benzene ring bodies, or benzol seem to be more difficult to break up than the paraffin-chain bodies, and the latter have a better diffusibility than the former. They are, therefore, more active and seem to give better results in combustion, though for this same reason they are more dangerous. The calorific value of bituminous tars in general is lower than that of lignite tars or petroleum products. Petroleum benzines require approximately 40 volumes of air, whereas the heavy petroleum products require approximately 100 volumes of air for complete combustion.

Petroleums and Tar Oils.

Petroleums, gas oils and lignite tar oils, lend themselves to gasification readily, and they leave practically no residue, giving them peculiar value in an oil engine. Anthracene and creosote oils gasify fairly well. Paraffin-chain bodies, in general, gasify very readily and are suitable for heavy-oil engines. Benzene-ring bodies, however, volatilize with more difficulty. They volatilize regularly and do not have the explosive tendency to be noted in the several kinds of petroleum products, which gives the latter the value peculiar to oil engines. An oil, to give best

results in a heavy-oil engine, should show a tendency to volatilize suddenly at some given temperature on heating, and not to give off vapors regularly and uniformly, that is, distil with the rise in temperature. To this tendency to sudden volatilization or explosion, in contradistinction to regular volatilization or uniform distillation, is due the value as a fuel in the heavy-oil engine (unlike the explosion engine fitted with carburetor and igniter where the time of combustion is so short).

Bituminous tar oil and tar itself are used in engines in which the fuel is ignited by sparks, glow points, hot retorts or hot cylinder heads.

Lignite tar oils and bituminous tar oils mixed with 25 per cent anthracene give good results in a heavy-oil engine. In general, in a good paraffin oil the ratio of hydrogen to carbon, as shown by analysis, should be 10 to 15, and in bituminous tar oils the ratio should be about 10 to 12.5.

Fuels That Can Be Used in Heavy-Oil Engines.

Petroleum Products.

Many liquid fuels can be burned successfully in heavy-oil engines. Petroleum products of all kinds from whatever source, from the lightest lamp oils to semi-fluid residues, have from time to time been successfully used.

Benzines of specific gravity of 0.7 to 0.71 from Pennsylvania, of a specific gravity of 0.715 to 0.725 from India, and of a specific gravity of 0.745 to 0.755 and distilling between 140 deg. to 160 deg. C. from Roumania burn well, but are expensive.

Lamp oils and naphthas of specific gravity 0.85 to 0.95, distilling between 150 deg. and 300 deg. C., and of 10,300 to 10,800 calories, burn well but are also expensive.

"Solar oil" and "gas oil," with a specific gravity of 0.8 to 0.93, and distilling between 300 deg. and 360 deg. C., with a flash point of 65 deg. to 150 deg. C., and generating 190 to 200 horsepower-hours per 10,000 calories, also burn well, are cheap, and are produced in considerable quantities.

Lima fuel oils, such as Eagle oils, gas-oil tar distillates, and Austrian and Russian fuel-oil residues have a specific gravity of 0.943 to 0.952, a heating value of 10,500 calories, a viscosity of 3.6 Engler, and a flash point of 76 deg. C.

Paraffin-oil residues have a specific gravity of 0.86 to 0.89 and a heating value of 9,750 calories.

Fuel-oil distillates from California and Texas have a specific gravity of 0.84 to 0.9 and a flash point of 60 deg. to 100 deg. C.

Asphaltum oils containing as high as 21 per cent asphaltum, according to a statement made to the author by W. R. Sands of San Francisco, have been burned with success.

Mexican oils have a specific gravity of 0.878, a heating value of 10,000 calories, a viscosity of 50 deg. C., 1.64 deg. Engler, and a flash point of 44 deg. C.

"Steinkohle" Oils.

"Steinkohle" oils are heavy-oil distillates, having a specific gravity of 1.04.

Anthracene-oil distillates have a specific gravity of 1.1 and a heating value of 8,959 calories.

Tar-oil mixed distillates have a specific gravity of 1 to 1.1 and a heating value of 8,800 to 9,000 calories. These may be even so heavy that it is necessary to heat them in order that they may become fluid enough to flow.

Bituminous Oils.

Bituminous oils are from various forms of gas retorts, as inclined rotary, vertical and horizontal. The vertical-oven tar oils have a specific gravity of 1.10 to 1.18, contain 0.2 to 4.3 percent of free carbon, have a flash point between 40 deg. and 71 deg. C., and a viscosity of 1.8 deg. to 45 deg. Engler. They are mobile and have little free carbon. The horizontal-oven tars have a specific gravity of 1.16 to 1.25, contain 14.9 to 33 percent of free carbon, have a flash point between 71 deg. and 90 deg. C., and viscosity of 16 deg. to 51 deg. Engler. Two gallons of tar oil develop approximately 29.7 indicated horsepower-hours. These tars burn readily in heavy-oil engines, but on long running, deposit some carbon in the cylinders. They should first be distilled and the crude distillate used, although, if the tar is perfectly mobile, complete combustion is obtained readily.

Lignite Oils.

The distillates of lignite oils are represented by light benzene of a specific gravity of 0.8 to 0.82, and solar oils of a specific gravity of 0.82 to 0.835, containing 13 to 14 percent hydrogen. Benzene is successfully used in a sparking or explosion engine, because in this type of engine the time for volatilization and diffusion is greater than it is with a self-igniting heavy-oil engine. It has a tendency, however, to develop smoke. Light tar oils of a specific gravity of 0.845 to 0.87 and heavy tar oils of a specific gravity of 0.875 to 0.9, containing 11 to 13 percent of hydrogen, have been burned successfully.

Paraffin-oil distillates have a specific gravity of 0.898 and a heating value of 9,790 to 9,836 calories. Creosote-oil distillates have a specific gravity of 0.957 and a heating value of 9,880 calories.

Turf (Peat) Oils.

Tar oils from the distillation of peat require more heat and time for volatilization than lignite tar oils, but an oil having a specific gravity as low even as 0.8533 has been successfully burned in a heavy-oil engine.

Shale Oils.

The shale oils of Scotland of a specific gravity of 0.74 to 0.98 have been used successfully.

Vegetable Oils.

Vegetable oils, such as peanut oil of a specific gravity of 0.916 to 0.92, cocoanut oil of a specific gravity of 0.925, castor oil of a specific gravity of 0.96 to 0.967, cottonseed oil of a specific gravity of 0.913 to 0.93, and palm oil of a specific gravity of 0.85 to 0.86 have been burned satisfactorily in a heavy-oil engine, but they are expensive and at present are not to be considered available, although in an emergency they could be used.

Animal Oils.

Animal oils, such as lard oil, of a specific gravity of 0.913 to 0.919, like the vegetable oils, can be used successfully, but they are high priced and only in an emergency are they to be considered as a fuel.

Alcohols.

A mixture of 90 percent alcohol and 20 percent benzene has been burned successfully in the heavy-oil engine. However, it has been found advisable to warm the engine by first starting it on a more volatile petroleum product such as benzene.

Wood Oils.

Wood oils or creosote distillates of a specific gravity of 0.841 to 0.877 have also been used to a limited extent with success.

In short, the following oils and mixtures of them have been used successfully in heavy-oil engines, provided they were mobile, free from free carbon, grit and water, and were low in sulphur:

Petroleum products: Gasoline, lamp oils of all kinds; naphthas; gas oils; fuel-oil distillates; "masut" or residues from the crude oils of Russia; and crudes, if mobile.

"Steinkohle" oil products: Heavy oils; anthracene oils; and tar oils.

Bituminous oils: Retort oils of all kinds.

Lignite products: Benzene; solar oils; paraffin distillates; and creosote oils.

Turf oils: Creosote oils.

Shale oils.

Vegetable oils: Peanut oil; cocoanut oil; castor-bean oil; cottonseed oil; and palm-seed oil.

Animal oils.

Alcohols.

Wood oils: Creosotes.

An intelligent study of the oil engine is essential to proper operation, regardless of the oil used, and with this end in view the following discussion, together with tables showing the consumption and cost of oil are given.

In order to utilize the existing equipment many of the gasoline engines now in service have been converted to kerosene and distillate engines by the addition of attachments for pre-heating the oil to (or near) the flashing point before it enters the cylinder. These attachments consist of generators or mixing chambers wherein the oil is heated by the exhaust of the engine. They are made in various sizes and types, both for throttling and for hit-and-miss governors. With these attachments the engine is generally started on gasoline and is allowed to run on this fuel until the cylinder and generator are heated when the oil is cut in. On other types a retort is provided where the oil is converted into a vapor or gas by heating the retort with a blow torch. Either method requires from five to ten minutes to start an engine running on oil. Electric ignition is used as with gasoline engines. Very little carbon trouble is experienced with the use of these attachments and the lubrication required is about the same as with a gasoline engine.

A series of tests of various fuels were made, pumping against a total head of 61 ft., with an 8-in. by 10-in. single cylinder, double acting pump, direct connected to a 6 h. p. four cycle, horizontal gasoline engine equipped to run on kerosene and distillates as well as gasoline, and controlled by a throttling governor. This engine was one of the first gasoline engines ever equipped to operate on low grade oils and has been operated continuously on distillates from 36 deg. to 42 deg. Baume for the past six years.

The fuels used are shown in Table 1.

As will be seen from the above figures the distillate was the most economical of the fuels used, the cost for distillate per water horsepower-hour being 53 percent of the cost of pumping with kerosene, and only 27 percent of the cost of pumping with gasoline. The high cost of alcohol eliminates it as a fuel for pumping water and the result of the test is merely submitted as a comparative feature. No doubt better results could have been obtained by reducing the area of the combustion chamber as more compression is required to secure economical results from the use of alcohol in internal combustion engines. The power obtained from the use of kerosene was practically the same as from the distillate, the only difference being in the price of the two fuels. The gasoline

Table 1.

Distillate,	40 deg. Baume	Flash 150, Burn 145
Methyl alcohol,	40.5 " "	Burns at same temp.
Kerosene,	46 "	Flash 124, Burn 170
Gasoline,	62 "	Burns at same temp.
Motor spirits,	58 "	" " " "

Efficiency Fuel Tests.

	Distillate.	Alcohol.	Kerosene.	Gasoline.	Motor Spirits.
Lbs. fuel per hr.,	5.145	6.062	4.943	5.373	4.755
Cost " " "	0.0347	0.35	0.06	0.1313	0.0975
Pump, rev. per min.	43.35	43.32	43.54	43.72	43.79
Pumped, gal " "	175.	177.8	176.8	176.8	178.1
Water horse power,	2.69	2.73	2.72	2.72	2.74
Lbs. fuel per h.p.h.	1.91	2.22	1.91	1.97	1.74
Cost " " " "	0.0129	0.1282	0.0220	0.0483	0.0356
Cost " " gal.,	0.04625	0.40	0.08	0.15	0.13
Pints per hr.,	6.	7.	6.	7.	6.
	Deg.	Deg.	Deg.	Deg.	Deg.
Temp. of cyl. start,	165	90	135	46	46
Temp. of cyl. run,	145	145	145	130	125
Temp. of inlet air,	110	125	120	60	60

test shows such results as might be obtained from the average gasoline engine under the same conditions. The fuel known as "motor spirits" which has been widely advertised as a substitute for gasoline operates under practically the same conditions as gasoline. An objectional feature of this oil is a disagreeable odor which would perhaps make it undesirable for use in certain localities.

A 12 h. p. four-cycle gasoline engine with a hit-and-miss governor pulling a 7½ in. by 30 in. working barrel in a deep well was equipped with a generator for burning low grade oils. Comparative tests showed that the engine consumed the same amount of 39 deg. distillate per horsepower-hour as gasoline. The difference in cost of the two fuels, however, resulted in a saving of $.0434 per horsepower-hour in the use of the distillate. The cost of pumping water at this point is comparatively high, owing to the fact that the water is pumped with a single acting deep well cylinder.

The tabulated results obtained are shown in Table 2.

The heavy oil engine is a comparatively recent development and is being extensively used in railway water stations, as well as for other service. The most popular engine of this type is the two-cycle oil engine constructed in units of 50 h. p. and under using heavy oil as fuel. This type of engine is very often confused with high compression engines operating on the Diesel principle or with the converted gasoline engines using kerosene and distillates through a carburetor or mixing valve.

The cycle of operation of the Diesel engine is to compress air to 450 or 500 lb. per sq. in., generating a temperature of approximately 540 deg. C. Into this highly heated air the fuel is injected during the return, or second stroke of the piston in a finely atomized form at such a rate as will maintain a constant temperature while burning and in such quantity as will do the required work for each stroke. The expanded gases of combustion are forced out of the cylinder during the third stroke, while

Table 2.

	Gasoline.	Distillate.
Pounds of fuel per hour,	11.746	12.005
Cost of fuel per hour,	21.875	8.093
Revolutions of pump per minute,	24	24
Gallons pumped per minute,	124	124
Water horse power,	3.4	3.4
Pounds fuel per horse power hour,	3.458	3.53
Cost of " " " " "	0.0643	0.0209
Cost of " " gallon,	0.125	0.04625
Pints per hour,	14	14
Cost per 1,000 gallons water pumped,	C.029	0.0108

the fourth stroke draws fresh air into the cylinder. This is the sequence of events in a four cycle engine. By expelling the burned gases with fresh air the necessary functions can be performed in two strokes of the piston, producing the so-called two-cycle engine.

The above mentioned engine should not however be confused with the two-cycle oil engine used in railway and other pumping stations and termed the semi-Diesel engine. In order to avoid the high compression pressure and the resulting complication of design necessary in the Diesel engine this so-called semi-Diesel engine has been devised, which does not compress the air sufficiently to raise the temperature to such a point that it will ignite the injected fuel spontaneously. It is this type of engine which we have to deal with, particularly with the two-cycle valveless injection engine, in which the compression has been reduced, adding the required temperature in a heated combustion chamber. This engine is governed by throttling the oil supply and ignition is accomplished by means of a hollow ball. This ball is heated by a blow torch before starting, but after the engine is running the heat is maintained by the successive explosions. The fuel is introduced through fuel valves similar to the Diesel engine but much less compression of air is required, the compression of the semi-Diesel engines being from 80 to 130 lb. The crank case compression is 1¾ to 3½ lb. Although these engines theoretically have a less efficient heat cycle than the Diesel they gain in simplicity of construction.

Intelligent lubrication is essential to the proper operation of the oil engine. Improper lubrication contributes largely to oil engine trouble. The high speeds and temperatures at which these engines work necessitates a continuous and skillful use of good oil. A great deal depends upon the proper lubrication of an engine of this type and the prevention of the carbon forming in the cylinder. The destruction of the lubricating oil by combustion can not be prevented. Just what occurs to the oil in an internal combustion engine can not be entirely explained, but there is no doubt that a great deal of it is burned along with the fuel oil and as long as this is true it is necessary that complete combustion take place in order that a residue of unburnt oil shall not be left in the cylinder in the form of carbon.

The lubrication of the steam engine or pump is comparatively simple. In steam engines there is a certain amount of moisture to assist lubrication, but the flames of an oil engine dry the internal surfaces and unless the proper amount of lubricating oil is applied, the cylinder, piston and rings soon begin to suffer. In a steam engine or pump the temperature will at the most reach about 500 deg., while in an oil engine it rises to as high as 2,500 deg. Added to this is the fact that the piston speed of an internal combustion engine is from three to four times that of a steam engine or pump. Consequently the oil engine

requires a different method of lubrication and a great deal more of it.

Engines of this type are liable to suffer from carbon trouble and resultant deterioration owing to the fact that an excess of oil injected into the cylinder breaks up into volatile compounds, such as the naphthas, heavy tar-like oils and free carbon. Overloading the engine also will cause carbon trouble. When an engine is working up to its maximum power a momentary overload will cause an excess of oil and the resultant accumulation of carbon owing to the fact that the oil engine is not flexible enough to adjust itself instantly to the varying loads as does a steam engine or pump.

The carbon troubles may be reduced to the minimum by the use of the proper oil. Fuel oils vary in quality the same as hard and soft coal and even to a greater extent. As a result some oils are better suited for use in oil engines than others. While it is possible to burn almost any oil that will flow freely, the best results are to be obtained from oils of a paraffin base from 30 to 36 deg. Baume.

A number of tests were conducted on a 25 horsepower oil engine with a 10 in. by 14 in. cylinder belted to a 10 in. by 12 in. duplex power pump, using seven different kinds of oil ranging from a heavy fuel oil of an asphalt base to a light distillate from a paraffin base. A brief description of the oils used follows:

No. 1. Diesel fuel oil, 26 deg. Baume made from asphaltum base crudes from Texas and Louisiana fields.

No. 2. Gulf fuel oil, 24 deg. Baume, made from asphaltum base crudes from the Oklahoma fields.

No. 3. Narico distillate, 39 deg. Baume, made from semi-paraffin base Mid Continent crude oils.

No. 4. Motor oil, 42 deg. Baume made from paraffin base crude oils from the Cushing, Oklahoma fields.

No. 5. Navy fuel oil, 26 deg. Baume made from asphaltum base crude oils from Texas and Oklahoma fields.

No. 6. No. 1 fuel oil, 32 deg. Baume, A non-sulphur oil with a paraffin base from Illinois crude oils.

No. 7. Kentucky crude oil 32.5 deg. with a Baume paraffin base.

Table 3 gives the results obtained from the use of the above oils.

Table 4 and Table 5 give the result of tests conducted in pumping with 4-in. centrifugal pumps using two-cycle semi-Diesel oil engines for power, one pump being driven by a 25 horsepower horizontal engine and the other by a 25 horsepower vertical engine, and both pumps being belt driven.

Table 4 gives the result of one hour's run while Table 5 gives the hours run and the costs for a period of four months for each engine.

Tables 6 and 7 show the results obtained in pumping with a 25 horsepower horizontal two-cycle heavy oil engine belted to a 10 in. by 12 in. double acting duplex power pump and a 30 horsepower vertical two-cycle heavy oil engine belted to a 11 in. by 12 in. single-acting triplex power pump. Table 6 gives the results for one hour's run and Table 7 the cost for a period of four months for each engine.

Though the oil engine can not yet be considered as fully developed, it has passed the experimental stage, and while it is perhaps not as reliable under all conditions as a steam engine or pump, much of the prejudice against it is undoubtedly due to lack of experience in handling. With the present imperfect knowledge of what the engine is capable of doing and of which particular oils may be burned in it, one can not speak conclusively, but there is no doubt that the future of the engine is assured.

C. R. Knowles,
C. A. Lichty,
J. Dupree,
J. J. Murphy,
Committee.

Table 3.

	1	2	3	4	5	6	7
Gal. oil per hour,	1.51	2.29	2.04	1.88	2.19	2.00	2.10
Pounds " " "	11.30	17.33	14.07	12.20	16.38	14.46	15.07
Pounds oil per w.h.p.	1.02	1.12	0.98	0.80	1.01	0.96	0.85
Engine r.p.m.	346	337	345	345	342	338	328
Pump r.p.m.	40	39	40	40	40	39	38
Gal. pumped per min.	444	603	583	592	586	580	577
Cost of oil per gal.	0.029	0.029	0.031	0.03	0.029	0.025	0.016
Cost of oil per hour,	0.044	0.066	0.063	0.056	0.063	0.05	0.035
Cost per 1,000 gal.	0.0016	0.0019	0.0022	0.0016	0.0018	0.0015	0.0009
The costs given cover fuel only							

While these tests are not conclusive they indicate the wide range of fuels it is possible to burn in these engines.

Table 4.
Test of One Hours Run.

	Horizontal Engine.	Vertical Engine.
Engine, rev. per min.,	315	380
Pump, " " "	1587	1320
Gal. pumped " "	471	571
Total head in feet,	77.38	79.69
Fuel oil consumed in gallons,	2.25	2.65
Water horse power,	11.15	11.5
Brake " "	21.4	22.1
Cost of fuel oil per million gal.,	$1.67	$1.97
Cost of fuel oil per gal.,	0.0253	0.0253
Cost per horse power hour,	0.0026	0.0030

Table 5.
Cost of Fuel and Lubricants for a 4 Months Run of Each Engine.

	Horizontal Engine.	Vertical Engine.
Total number of hours run,	331	316.
Gallons of water pumped,	9,930,000	9,480,000
Cost of kerosene,	$3.78	$1.56
Cost of fuel oil,	18.01	18.47
Cost of lubricants,	9.20	10.20
	$30.99	$30.17
Cost per million gal. pumped,	$3.12	$3.18

Table 6.
Test of One Hour's Run.

	Duplex Pump, Hor. Eng.	Triplex Pump, Vert. Eng.
Engine, rev. per min.,	342	396
Pump, " " "	40	44
Gal. pumped " "	586	640
Total Head in feet,	104	106
Fuel oil consumed, gals.,	2.19	2.70
Water horse power,	15.33	17.5
Brake " "	20.44	23.33
Cost of fuel oil per million gal.,	$ 1.80	$ 2.00
Cost fuel per gallon,	0.029	0.029
Cost per h. p. h.,	0.0031	0.033

Table 7.
Cost of Fuel and Lubricants for 4 Months Run of Each Engine.

	Duplex Pump, Hor. Eng.	Triplex Pump, Vert. Eng.
Total No. of hour run,	687	677
Gallons water pumped,	24,732,000	24,372,000
Cost of kerosene,	$ 8.52	$ 9.78
Cost of fuel oil,	26.26	31.37
Cost of lubricants,	17.10	22.04
Total cost,	51.88	63.19
Cost per million gallons pumped,	2.09	2.54

DISCUSSION.

Subject No. 1, Water Supply.

(Part 1, Intakes and Intake Lines.)

The President:—As this paper deals with two entirely different subjects, I think it is advisable that we should take up whatever discussion we have on the first part of it before reading the second part. We will now be glad to hear any comments you may have to offer.

P. J. O'Neill (N. Y. C.):—I would like to ask Mr. Knowles to what lift he limits centrifugal pumps.

C. R. Knowles:—We have found that the best practice is to limit the suction lift of centrifugal pumps to 12 ft.

The President:—I didn't understand from the reading of the report whether there was any disadvantage in having any points within the intake line above the general line of the grade. Is that information in the report?

C. R. Knowles:—It was the intention to state in the paper that a suction line should preferably be laid to grade with a fall toward the source of supply to avoid any possibility of air pockets forming in the line.

The President:—That is what I had in mind.

A. Montzheimer (E. J. & E.):—It has been my experience that the lower you can keep the head the better. We have one turbine pump to which the water flows by gravity, which is of great assistance. It increases the capacity of the pump. The Illinois Steel Company has several large pumps at Gary, in a specially constructed pump house in which the pumps are lowered to within about 3 ft. of the water; so the lift is very little. I think you will find that advisable.

C. R. Knowles:—When I mentioned 12 ft., I referred to the maximum suction lift. It is not always possible to maintain a uniform lift on account of the varying height of the stream during flood stages. It is preferable to keep the pump as near to the water as is practical. We are putting in a centrifugal pumping station at Kentwood, just north of New Orleans, where we will have only a 6 ft. lift.

The President:—I would like to ask Mr. Montzheimer whether the water flowing through the pump is of any real assistance in increasing the capacity of the pump when it is pumping, or only in the priming.

A. Montzheimer:—We have a peculiar condition at Joliet. We are pumping 1,000,000 gal. of water a day. At times we require high pressure for washing out engines, located about two miles from the pump. After using different suction pipes we have found that the best results are obtained by getting the water by gravity. The pump is located in a power plant and instead of taking water from the tail-race, we take it from a pit above the floor of the pump house, so that it flows by gravity. We have a valve in the suction pipe so that we can control the flow in that way.

C. R. Knowles:—A centrifugal pump will deliver more water as you decrease the suction lift. Modern centrifugal pumps are usually designed for a certain head. When you reduce the head on the pump you increase the capacity.

The President:—Is it not a fact that in the efficiency of the pump you consider the suction and the discharge head; that is, the addition of the two as being the actual head of the pump, and that if you shorten the suction you can lengthen the discharge approximately the amount you shorten the suction?

C. R. Knowles:—Yes. The suction and the discharge head are considered as the total head of the pump.

The President:—Isn't it a fact that, if you take the suction pipe off altogether and have no suction, you can have the discharge not longer than the combined length of the suction and the discharge?

C. R. Knowles:—That will depend largely on the design of the pump.

The President:—Ordinarily?

C. R. Knowles:—Ordinarily, I would say no. If you were going to take the water under head, it would be necessary to design the pump along different lines than when lifting the water against a certain suction head.

L. A. Cowsert (C. N. O. & T. P.):—Speaking of the suction and discharge of pumps, there is very little comparison between the length of the discharge line and the suction line. I think the shorter you can make the line the better service you will get out of it and the better the pressure. A vacuum of 12 ft. is the maximum; less than that is better. In figuring the discharge it is my experience that it is influenced very little by the suction line.

C. R. Knowles:—As I understood, the President's remarks had reference to decreasing the suction head and increasing the dis-

charge head to correspond, that is, reducing the suction head from 12 ft. to 2 ft. would permit increasing the discharge head 10 ft.

If the high end of the suction line is towards the source of supply—farthest from the pump—an air pocket may form and interfere with the proper operation of the pump.

P. J. O'Neill:—I always use a primer on a centrifugal pump.

C. R. Knowles:—You can't get the air out of the pocket. The water will carry more or less air and it will accumulate at the high point.

The President:—To clear this up, it appears that Mr. O'Neill and Mr. Knowles are working from two different points of view. In my opinion Mr. O'Neill has the water flow to this low point and the suction is only composed of the short vertical riser—

P. J. O'Neill:—That is right.

The President:—And Mr. Knowles is working on the assumption that you have to pump the water over some point at the source of supply and then let it flow down toward the pump.

C. R. Knowles:—Mr. O'Neill's suction line would necessarily have to be laid lower than the source of supply and carried horizontally with a fall toward the source of supply. There are many conditions under which that practice would mean very expensive work when putting in the suction line. For example, if you had a pump working against a 12-ft. suction lift that would mean a 12-ft. trench.

P. J. O'Neill:—So far as the air pocket is concerned, you have to have a foot valve.

C. R. Knowles:—In priming a centrifugal pump, the air is driven out through the pump.

P. J. O'Neill:—Necessarily.

C. R. Knowles:—The high point would have to be at or near the pump, to drive all the air out of the line.

P. J. O'Neill:—It would have to have an open end on the pipe higher than the intake and let the air in—better with an intake service and vertical pipe at the other end.

C. R. Knowles:—We have three pumping stations on southern rivers, one a centrifugal pumping station, and two with reciprocating pumps, where we have variations in water level of 54 ft., 38 ft. and about 32 ft. You understand the disadvantage in excavating for a suction line to that depth.

P. J. O'Neill:—Mine are not under those conditions.

C. R. Knowles:—Of course there are conditions where Mr.

O'Neill's scheme could be carried out, but as a general thing I would not advocate it as good practice.

The President:—I think it will be agreed that in Mr. O'Neill's scheme his suction is only that part of the vertical riser pipe, and the horizontal line is a free-flowing intake. The water flows in of itself, and the suction pump could only be considered the vertical end, because under no conditions would the pump suck in water through the horizontal pipe. The acceleration is largely due to the water being taken away from the end of it. Of course it is well known that a large number of the centrifugal pumps are the horizontal pumps that are submerged entirely in the water; but I believe the only advantage is in priming. There is no additional advantage in pumping. Is that right?

C. R. Knowles:—As a usual thing they are not as efficient as horizontal pumps. This submerged type of vertical pumps is used chiefly as bilge pumps or pumps for handling sewage.

P. J. O'Neill:—I am not referring to that.

A. Montzheimer:—I think possibly there is some confusion in regard to the use of the turbine pump. Suppose the head was 100 ft. from the source of supply to the point of delivery. You would certainly get better results from the turbine pump by having it placed within 3 ft. of the source and pump the water 97 ft., rather than to have the turbine 10 ft. from the source and pump 90 ft. It is very essential that you get close to the source. It does make a difference in the capacity of the pump to get it so close to the source. It increases the efficiency.

C. R. Knowles:—Mr. Montzheimer is entirely correct, particularly after the pump has become worn. There is another point of advantage in having a low suction lift. You can prime the pump much more quickly.

B. F. Pickering:—Isn't it more economical in operation and maintenance as well?

C. R. Knowles:—It is.

L. A. Cowsert:—When inspecting pumping lines, I found a case at Danville, Kentucky, where the pump was operated automatically; they had no primer but an attendant had to go and look at the pump once a day. We found the pump did not prime itself and that it would run for an hour and get hot. We had an opening to let the air out but this was not sufficient to handle it. Later on we looked for trouble in the line; but we could not find it in the suction line, and we put an opening on the second stage. A two-stage pump must

have an opening on each stage to get rid of the priming. I might say that a man would have to look after it in case the packing was bad. We found our trouble was due to the packing.

C. R. Knowles:—You frequently have to do that. You have to bleed the air on centrifugal pumps at the highest point of the pump. With a two-stage pump, relieving the air from one stage of the pump will not affect the air on the other stage. The air will still be present above the line of the propeller shaft. Under a low head the first stage would of course force the water through, but we are assuming that the one-stage will not force it against the working head.

W. E. Alexander:—It is true that the air in the suction must be removed to get proper service, the same as in a discharge pipe. There may be a little raising and lowering in the grade of the pipe. The presence of trouble depends largely on how abrupt that grade changes, as the air may flow along with the water and be disposed of under discharge if the angle is slight, while in the suction it should be bled out by a valve in some way. We had a plant with an 8-in. Eclipse pump, where the water in the river would rise and fall perhaps 22 or 24 ft. For that reason we had to place the pump house some distance from the river, and had to bring the suction pipe up with about a 20 ft. lift from low water. At high water there was no trouble in getting the water to the pump, but we found that we could not get the water to come to the pump at low water. We thought there must be some leak in the castiron pipe and we dug it out and found that it was tight. Yet it wouldn't do the work. Then we lowered the pump at the pump house five feet, and we thought that we would get the water up by syphoning. We did not succeed. We then put an air chamber at the pump to allow for the pulsations of the water, and still we didn't succeed in bringing the water. We secured enough water from a brook to feed a reservoir which we dug to supply our needs ever since, but we have never brought water from the river in that pipe. I would not recommend laying pipe a long distance, and then going down to a pump.

B. F. Pickering:—I have a pump in a section of 6-in. castiron pipe line 1300 ft. long laid at various grades, and creating all sorts of air pockets and with a lift of approximately 18 ft. It has been in about 20 years. I want to know if anybody can tell me of any efficient way or any device to install at the high points on that section of pipe line to take care of the air. We have infinite trouble with it. We have to dig the pipe out every 2 or 3 years and re-calk it.

Can somebody tell me an efficient way to remedy the trouble, other than to dig the pipe down to an even grade?

C. R. Knowles:—I don't know of any remedy that I can suggest for a condition of that kind.

L. A. Cowsert:—I think it is well known to most of the members that placing a little air cock in a gravity supply line or at a pocket like that gives one a chance to release the air. By relieving them with air cocks, (a little gate in the bottom and a rod to open and close it) one can let all the air out as he is priming the pipe. This will work in a gravity supply.

P. J. O'Neill:—As I understand it, the line Mr. Pickering refers to is not a gravity supply.

L. A. Cowsert:—Priming the suction pipe would dispose of the air.

C. R. Knowles:—No; an air cock will only tend to let the air into a suction line.

L. A. Cowsert:—But a primer past the pump will not fill the suction line.

C. R. Knowles:—Mr. Pickering is now priming the pipe and letting the air out at the high points.

James Dupree:—I would suggest that if Mr. Pickering would move his pump to the other end of the line and shove the water through, it will accomplish the desired result.

B. F. Pickering:—Conditions are such that we can't do that.

R. H. Reid:—One point may not have been considered. There is a certain amount of air in all ordinary water. Put it through a syphon and as soon as you reduce the pressure or create a vacuum, the air is drawn from the water, and air pockets form. I don't think the fact that the air is in the water is taken into account. The air pockets are not always the fault of leaks in the pipe or loose joints, but are formed by the air in the water.

J. B. Sheldon:—I would like to ask Mr. Knowles whether he can give the members any information about an automatic air release. Mr. Reid has touched on the matter of air in the water. If you can have an automatic air release you can solve the problem. We need such a device to get rid of air that collects either in rotary pumps or long syphons.

C. R. Knowles:—No automatic air release has ever been designed for a suction line, for the reason that you have nothing to make an air valve operate where you are taking water against a suction lift. There are a number of very good air valves on the market.

They are designed however for use where you have the pressure within the pipe, and not to operate under a vacuum.

J. B. Sheldon :- Isn't it possible to have a small source of supply at some high point to release the air and fill the pipe with water, that will act automatically and that can be released periodically?

C. R. Knowles :— It can be done. As I understand it Mr. Pickering is doing this.

The President :—That is, a valve at the bottom and a valve at the top; open the valve at the top to fill it with water and then open the valve at the bottom and inject that much new water into the pipe line.

C. R. Knowles :—Yes, there are different forms of application.

J. Dupree :—The less the number of crooks in a suction line the better. Where you have to go over high places, I do not think it is very practical to maintain a suction line, for you will always have annoyance. The way I always build them is to put my pump as close to the water supply as I can and force the water the other way.

L. D. Hadwen :—A great deal is being said about suction lines, while a large portion of the paper deals with intakes and the screens used at intakes. A number of different screens are illustrated. Somebody here should be able to say something about the relative merits of the different screens.

The President :—Does anyone wish to make any more remarks on intake pipes?

J. Dupree :—As you all know, steel will not last very long under the ground. I know of one instance at Belle Plaine, Iowa, where a wooden intake pipe has been in use 35 years. I have my doubts of cast or wrought iron lasting that long.

C. R. Knowles :—With reference to the use of cast iron or wood pipe for suction lines in place of wrought iron pipe, there are conditions, as mentioned in the report, where excessive corrosion exists and where it would be necessary to use wood or cast iron pipe. I question the use of a wood stave pipe, very seriously. I do not think it would be suitable at all for an intake line where there is any suction.

J. Dupree :—Speaking of dunes, silt, leaves and other things at intakes, the end of the pipe must lay off of the bottom so that the stream can go under it as well as over it.

C. R. Knowles :—The committee is not familiar with all of the water supply conditions of the United States; but there are conditions, particularly in the south, where we could not keep the intake

line off of the bottom, for there are times when we have only a few inches of water in the stream, and the intake line is barely covered; but there are other times during flood periods when we may have 40 ft. of water, and when the water subsides we have the bank of the stream where the stream was before. During the flood stage the entire course of the stream may be changed and the channel may move in another direction. The strainer is an inexpensive and very effective device under favorable conditions.

L. D. Hadwen:—There is one type of intake that I don't think Mr. Knowles has mentioned in his paper and which we have had occasion to use where we have had reservoirs installed in a muddy river to allow the silt to settle. I refer to a floating intake that moves up and down with the level of the water. We recently constructed three of a series of six settling basins, at Mobridge, S. D., where I think the consumption is about 250,000 gal. in 24 hr. These floating intakes vary in elevation with the level of the water in the tanks in order to always draw from the surface of the water which carries the least sediment.

C. R. Knowles:—I can readily see how an arrangement of that kind might be of advantage under many conditions. It would not be possible to use such an intake in a stream where there are floating logs or ice or on a lake where there might be rough water.

J. Dupree:—I suggest that if Mr. Hadwen has any drawings that he send them to the secretary to insert in the proceedings.

L. D. Hadwen:—I will be glad to furnish them.

The President:—I think the matter of the intake pipe is pretty well taken care of. Has any one any questions in regard to strainers and foot valves?

J. Dupree:—In regard to foot valves, if I have to lift water to the surface from the bottom of the well, where the pump is on the surface of the ground, I put only a strainer on the end and a check on the horizontal pipe. The reason I do that is that if I have a foot valve on the end, and an 8-ft. suction, it is quite heavy and bunglesome. By putting a swing check valve in the horizontal pipe, all you have to do is to take the cap off and the valve comes out with it. All you lose in that operation is the gasket.

C. R. Knowles:—The question of foot valves and check valves was not gone into extensively, because there are so many complications of the check valve and the foot valve that they would make a book of themselves, and you could not recommend a device such as a check or foot valve that would cover all conditions. We have

to leave a good deal of it to the judgment of the man putting in the suction and intake lines.

J. S. Robinson:—I would like to ask how often these strainers have to be cleaned at an ordinary water station and how they can be placed so as to be accessible. We have a case at our shops in Chicago where we use about 3,000,000 gal. of lake water per day where we have trouble at times with fish. We have the ordinary fish traps on our 12-in. meters but sometimes when allowed to run for three weeks we take out as much as 30 lb. of fish.

C. R. Knowles:—That is a pretty hard question to answer, because it depends on how much material you have in the water. A 10-in. strainer of this type installed at our Twenty-seventh street station in Chicago is shown in the report. We pump about 1,500,000 gal. a day there. During severe storms on the lake it is necessary to clean the strainers every 20 min. We are troubled at times with minnows, and I have known the time when we would get barrels of minnows from the strainers in 24 hrs. there. We clean them at times just about as often as we can change the valves. Under ordinary conditions, for instance in fair weather, we probably don't clean them oftener than every 3 or 4 days. It is a very simple operation to clean them.

J. S. Robinson:—About what is the cost of a 12-in. strainer as shown in the report?

C. R. Knowles:—Probably $400.

The President:—While on the subject of strainers, did the committee consider the foot valve and strainer that is used with the Emerson pump?

C. R. Knowles:—We have considered foot valves in a general sense, not as applied to any particular pump.

W. E. Alexander:—With reference to foot valves, I agree with the report that the opening should be large in all cases. The ordinary foot valve is large enough when it is clean, but when it gets dirty it is not, and it starves the pump. In all our intakes we have a reservoir or intake built at the river or the side of the brook and let the water run in or filter into it and arrange for the pump valve to enter with an elbow. We constructed that in the intake with wrought iron fixtures whether cast iron is used in the ground or not. We have a nipple with an elbow on it and lower that to any depth needed in the reservoir. If the water is high we may leave it up, so that a gravity-hinged valve will close all right at a level. To clean that pipe all we have to have is a wire or a chain attached to it, with

which we can pull it up out of the water at any time. In that way we can attend the foot valve, push it down again, and there is no trouble with it. The only way to take care of a foot valve properly is to have it hinged on an elbow, so as to be able to take it out and clean it. We have very little trouble with foot valves under those conditions.

C. R. Knowles:—Under those conditions is it not necessary to submerge the elbow also?

W. E. Alexander:—The elbow, usually, is under water; but if not, you can have it fixed with graphite so it will not leak.

C. R. Knowles:—A foot valve arrangement of that type is not unusual; as I understand it, the foot valve that Mr. Alexander refers to is within the intake sump or well.

W. E. Alexander:—Yes.

C. R. Knowles:—You should have but little necessity for cleaning it if the intake is properly screened.

W. E. Alexander:—We have a foot valve with a leather gasket that makes a hinge, which will become worn out and will unseat sometimes, causing a great deal of trouble if we don't pull it up and fix it. It is an easy matter to fix it.

L. A. Cowsert:—We had trouble with the use of a foot valve sump in the river at high stages at Oakdale, Tenn. We had men on the job continuously cleaning them.

The President:—It does not appear that there is much to be gained by discussing this subject any further, because we want to take up the second half of the paper.

W. M. Clark:—It appears to me that one must meet conditions as they come to you. In railroad work providing water for the trains is the first consideration. You can't get along without it. But the means of furnishing that water in a great many instances is made secondary. You have to design each individual water station on its merits to take the water from where it is to where you want it, using the best means that you have at your command. One member said that he uses the strainers and takes the check valve or foot valve off. That is all right. He may do that, but another man couldn't get along without them. I have in mind a water station on the Mahoning river, where we put in a concrete sump about 16 ft. square and about 10 ft. deep with the bottom about 4 or 5 ft. below the natural bottom of the stream. We fixed our suction line with swing joints similar to the method described by Mr. Alexander. We did not put in a strainer there, but we did put in a foot valve.

It has been in about 11 or 12 years and with the exception of cleaning it out about twice a year we have had no trouble whatever. On the lower side of the intake we put in a system of 1½ in. pipes, where the water came in;—enough to about double the area of the suction line. We have another 14,000,000 gal. reservoir, fed by gravity streams, the overflow from which is 48 ft. from the ground, and until we get down to 21 ft. above the ground we have a gravity supply for our water station. There we don't use any strainer, but we use a foot valve. The reason it has been necessary to use a foot valve there is that after we leave the reservoir, we go over several summits at a height of 21 ft. When the water gets below the 24 ft. level, and we have to start the pump, the water runs out and we have hard work getting the pump primed. We use a swing pipe, so that we always get the clear water from the top. We have an electric pump that pumps about 4,000,000 gal. every 24 hr. We have that in a sump in the Monongahela river and during high water we probably have to clean those strainers sometimes every hour; although in normal times we may not have to clean them once a month.

The President:—Mr. Knowles will now read the second part of the paper on Internal Combustion Engines.

(Mr. Knowles then finished reading the report.)

The President:—Let us take up the discussion of this part of the paper now.

E. T. Howson:—In listening to the report as Mr. Knowles read it I was impressed with the fact that the report deals with a subject on which there is very little information available. The development of the crude oil engine particularly, has been so rapid and conditions with reference to oil supply have been changing so rapidly, that anything that might be said today may be out of date tomorrow. Consequently I think the committee has done unusually good work in compiling and collecting such information as they have on such a live subject. Many of the men attending the convention here have not yet had occasion to use the data in this report, but in the way conditions are changing they are likely to have to fall back upon information of this character very quickly. I don't believe any of us can foretell what is going to happen in the fuel oil situation very many months ahead. With the rapidly changing prices and with the variety of the oils available the question is one of economical selection. If we have a large number of oils to select from we need these data to know what kind of oil we can use in a certain type of engine, and then which is the most economical. The subject is important,

yet I doubt whether the committee would be justified in putting another year's work on such a report, because this statement will apply for years to come.

C. R. Knowles:—Mr. Howson's remarks on the uncertainty of the oil situation are correct. The figures as to the cost of fuel are of no value, because the cost of oil has greatly increased. We are paying now probably 40 to 50 per cent more for oil than when these tests were made. As Mr. Howson says, conditions regarding fuel oil engines are changing so rapidly we can not anticipate what is going to be done tomorrow.

B. F. Pickering:—I think in view of all this, that we should confine ourselves more particularly to questions as to the development for particular uses rather than to a broad discussion of the whole subject.

The President:—In working upon a paper of this kind the chairman of the committee comes into possession of a large amount of information which is not generally known. If any one has any questions to ask Mr. Knowles I know that he will be only too glad to enlighten you.

W. M. Clark:—I don't quite agree with Mr. Howson as to the matter of not keeping this committee another year on water service. We have had a very good paper,—an excellent paper as far as it has gone,—and the water situation is one that no one committee can cover in one year. I think that we should have the subject of water supply taken up where they leave off this year and carry it on through to the delivery of water to the locomotive.

E. T. Howson:—I think Mr. Clark has misunderstood what I had in mind. I agree heartily with what he has to say. What I was referring to was with reference to the topic "Fuel for Internal Combustion Engines." I agree most heartily as to the continuance of the committee on water service.

SUBJECT No. 2

FLOORS FOR ENGINE HOUSES, SHOPS AND FREIGHT HOUSES.

REPORT OF COMMITTEE.

ENGINE HOUSE FLOORS.

The committee has not been able to secure all the data it desired on this subject and it, therefore, makes this report as one of progress and only on the floors most commonly used. The manner in which the work is to be carried out is described briefly in a general way and the committee has not included actual specifications because in many instances a general specification would not meet the requirements for different locations and conditions. The materials are referred to in the order in which they have been longest in use.

Planks.

Plank floors were formerly in common use but since timber has become scarce and the cheaper grades of such poor quality it is not considered economical to use all-plank floors for the less important houses. In the middle western territory hard maple, which may yet be secured at a reasonable figure, is the best available material for a plank floor, but where a considerable amount of water is used for washing out engines, etc., the planking is liable to curl up or swell which is decidedly objectionable. The cost of other materials of good quality is so great as to render them almost prohibitive, and unless the planks are less than 3 or 4 in. in thickness the floors are easily damaged and require frequent repairs.

Cinders.

Cinders are most universally used and make a good floor for small outlying enginehouses owing to their low cost and cheap maintenance. Such floors should be well crowned and kept well rolled and tamped as they are liable to be carried away by water when washing out engines. An improvement over the ordinary cinder floor is to place upon a cinder bed a coating of about 3 in. of limestone screenings tamped to a smooth surface. An ordinary cinder floor costs about 50 cents per square yard, while one with the top of screenings costs about 75 cents per square yard.

Wood Blocks.

Where the first cost is limited and engines are housed mainly for protection from the weather, an economical floor can be constructed of wooden blocks sawed from second hand pine or fir bridge timbers, such as ties, stringers, etc., and laid on end on a sand or cinder cushion. Such floors are of low first cost where second hand bridge timbers are available and are easily kept in repair. Floors of this description are still in fairly good condition after 15 or 16 years of service with no repairs. The blocks should be of a uniform depth but the other dimensions may vary. The cost of wooden block floors as above described ranges from about $0.90 to $1.00 per sq. yd.

Concrete.

Concrete has been used quite extensively with varying success. A very acceptable floor is built with 6 in. of concrete with a 1 in. neat cement finish. This does not require the use of hardeners or waterproofing materials. The concrete is stopped a sufficient distance from the edge of the engine pit to admit placing a jacking plank and to permit access to the wall plates and rail plates when it becomes necessary to remove them.

Brick.

Vitrified brick laid flat on a well-tamped gravel or puddled sand foundation 5 or 6 in. thick and with sand-filled joints can be laid at a cost of about $1.25 per sq. yd. The committee is of the opinion that a brick floor, laid on a concrete foundation, and costing $2 to $2.25 or more per sq. yd. is not to be recommended because of the cost.

Creosoted Wood Blocks.

Creosoted wood blocks, with the grain vertical, laid on a 2 in. sand cushion on a well puddled and rolled gravel bed with a 4-in. crown at the center between tracks have been extensively used and have given good satisfaction. Dry sand should be used to fill the joints. The blocks may vary from 4 in. by 3 in. to 4 in. by 6 in. in size. The depth of the blocks should be uniform and from 4 in. to 8 in., the greater depths naturally holding a better surface. This type of floor costs from $1.25 to $2.50 per sq. yd., depending on the thickness and local conditions. The same kind of floor laid on a 6-in. concrete foundation with asphalt filler will cost about $3.25 per sq. yd. This is an ideal engine house floor, as it is not so liable to damage as those constructed of harder materials when subject to falling objects, and it is almost impervious to water.

Mastic.

An asphalt mastic top 1½ in. to 2 in. thick on a concrete base has been in use for some time and as far as the committee has been able to learn has given very good results. Such a floor can be built for about the same cost as creosoted blocks on a concrete base as above described. As none of the members of the committee have had actual experience with this type of floor it is hoped that other members of the Association present may give evidence that will clearly show its merits and value as compared with the other types.

MACHINE AND BOILER SHOP FLOORS.

The materials commonly used for floors in machine and boiler shops, listed in the order of their longest use are plank, concrete, brick, creosoted blocks and mastic. The price of all of these floors runs about the same as in engine houses except that a concrete floor should be laid heavier to jack on, and should be not less than 5 in. and preferably 7 in. thick and laid on slag or gravel foundation with a 1 in. float. It is better if the float has a mixture of some first class waterproofing compound to make it impervious to water. This type of floor will cost about $2.50 per sq. yd. The concrete should be thoroughly troweled by machinery or by hand to a smooth, hard, even surface. Asphalt mastic on a concrete base is an ideal shop or engine room floor. In this case the concrete should not be less than 5 in. thick with a slip of felt saturated in asphalt next to the concrete. The asphalt mastic should be from 1½ in. to 2 in. thick, and as hard as possible on account of the grease that is liable to drop on it in such buildings.

Some of the committee are of the opinion that a creosoted wood block floor, with the blocks 4 in. thick and with an asphalt filler on a concrete foundation, practically the same as recommended for enginehouses, is a good floor and can be used in machine or boiler shops. The blocks should be rectangular in shape, of uniform length and free from any irregularities so as to prevent unevenness, as the floor wears

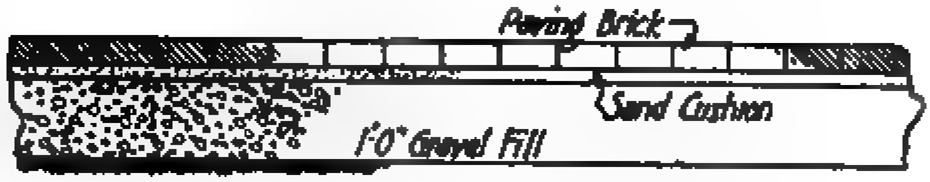


Fig. 1,– Engine House Floor.

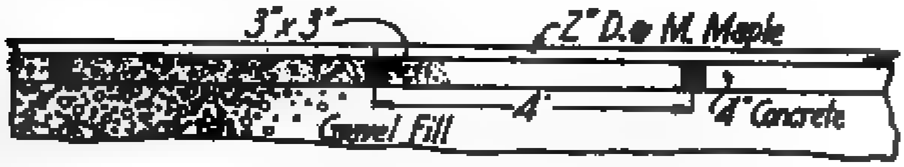


Fig. 2,– Shop and Engine House Floor.

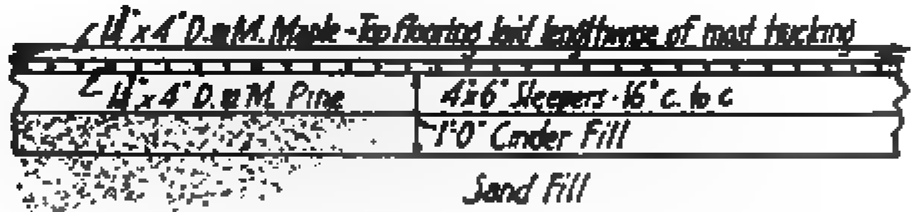


Fig. 3,– Freight House Floor.

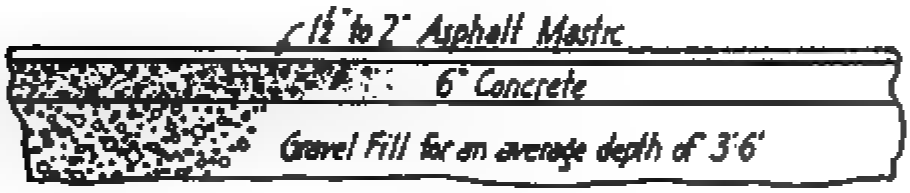


Fig. 4 Freight House and Shop Floor.
(Some Use for Engine Houses.)

Fig. 5,– Manufactured Wood Floor
Suitable for General Purposes.

under constant heavy use. It will be noted that the committee has recommended asphalt filler entirely instead of other tar products as the others soften under different degrees of temperature.

For creosoted wood blocks different varieties of woods can be used although those of Southern pine are most extensively employed. They should be laid with the grain vertical. In treating the blocks the committee prefers the creosote process with 150 to 160 lb. pressure to the chloride of zinc process.

WAREHOUSE AND TRUCKING FLOORS.

The committee has knowledge of an untreated wooden floor, as shown in Fig. 3 made of 2 in. D. & M. maple laid on 3 in. pine sub-planking on sand or gravel filling, the latter being preferable, that has been in use under heavy trucking for 19 years and is still good. This floor was subject to heavy freight trucking, such as commodities that are shipped by freight. We mention molasses particularly, because this commodity is more liable to leak than anything else except oil, and these floors had to be scraped several times to remove the scum of molasses and oil from the surface to prevent slipping.

Broken glass or slag is used instead of cinders where necessary to prevent rats from getting under the floor. Maple floors should be laid so as to truck with the grain of the timber. Wooden block and concrete floors are hardly satisfactory for trucking purposes.

A recent inspection was made at a large in-and-out freight house where the floors were of untreated maple, laid as shown in Fig. 3, one of the floors having been in service 16 years, and still being in first class condition at this time. This floor is supported on about 8 in. of cinders on top of a gravel filling, the sills resting in and on the cinders. The other portion of the house where the floor had been built and in use only ten years is now in a condition to be renewed for the reason that the filling used was loam with no cinder top to embed the sleepers. The moisture in the earth filling caused decay in the bottom side of the floor and it expanded to such an extent that it heaved and became out of surface, requiring the renewal of large portions. There is no doubt but that if the filling under this floor had been made of gravel with a cinder top, the life of the floor in this portion of the house would have equaled the other part.

The question has been raised regarding a cinder filling causing spontaneous combustion, but this is not the case where the cinders are placed on gravel and under an air tight floor, for the carbon in the cinders requires air to cause spontaneous combustion. There is no doubt but that if the sub-floor or the sleepers on which it rests were treated, this would add materially to the life of the floor.

For certain classes of floors a concrete surface is good as it costs 80c to $1 per sq. yd. less than a floor with a mastic top. There are several objections to this class of floor for trucking purposes on account of moisture, dust, slipping on account of frost or other substance, etc. They are very much objected to by truckers, as they are cold to the feet.

It is the opinion of the committee that the best trucking floor is made with a concrete base and an asphalt mastic surface from 1½ in. to 2 in. thick; this mastic well troweled but not hard enough to destroy its elasticity. Particular care should be exercised in getting mastic of the consistency to withstand various changes in temperature. In the south they can be made very much harder than in the north. The mastic should not be so soft as to flow when subjected to the trucking load. When these floors are properly laid the small creases which will occur on account of jams from barrels, etc., will in time iron out to a smooth surface in the regular course of trucking over the indentations. Such a floor costs approximately from $2.50 to $3.50 per sq. yd.

A wood floor, as shown in Fig. 5, is being put on the market

so constructed that the wearing surface is on the ends of a 1½ in. by 3½ in. block 2 in. in depth dovetailed into a base of either 1 in. or 2 in. plank. This floor can be laid the same as other plank floors with the wearing surface on the ends of the blocks. Such a floor might be found suitable to meet certain conditions and will cost, above the foundations, about $1.75 per sq. yd.

D. Rounseville,
J. S. Robinson,
G. A. Mitchell,
R. M. Bowman.
Committee.

The following on Asphalt Floors is copied from page 722 of Vol. 15, American Railway Engineering Association proceedings:

"Fig. 6 is considered to be an ideal floor for shops, if properly laid, with the correct materials and mixtures. Experienced supervision must be employed to get the best results. Similar floors are still in service and in fair condition after having been laid 25 years.

"Floors of this type will outwear others several times. They give the qualities which are desirable in a floor, and are without the objectionable features which have been mentioned in connection with other floors. They are easy to walk on and truck over, and the more the traffic the more dense and durable they become. They do not grind away material under truck traffic, they do not easily wear uneven, do not easily crack or disintegrate, are noiseless and dustless, and can be kept clean by broom or mop, or occasionally by flushing with a hose. They are sanitary, water-and fireproof, and are easily repaired. The filling and concrete subfloors are laid the same as for other types of floors. The top of the concrete should be drawn out under a straight edge struck off, but not troweled.

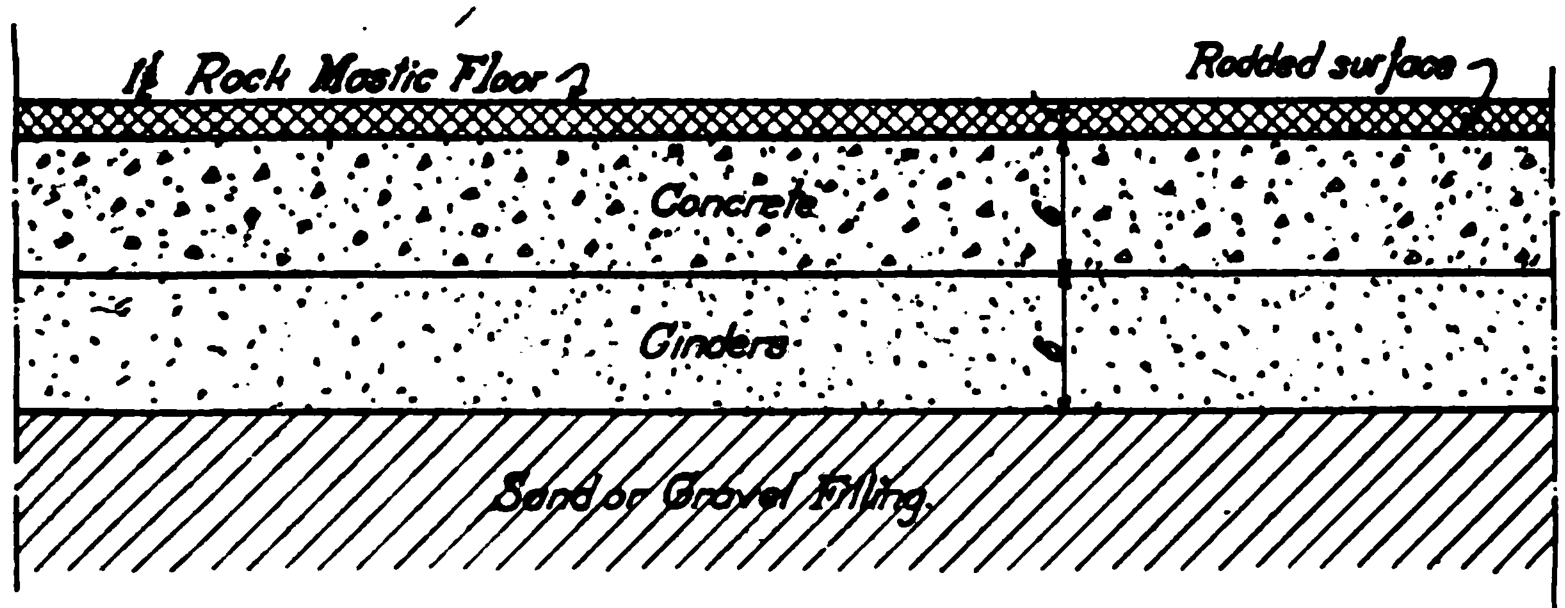


Fig. 6. Rock Mastic Floor.

"Mastic blocks should be delivered on the ground plainly marked with name of the brand, and broken up before placed in the mastic boiler. Asphalt flux should then be added and both allowed to cook, until the mastic blocks are entirely melted. Washed torpedo gravel, torpedo sand, crushed limestone or granite, in the proper percentage to give the required hardness should then be added, and thoroughly mixed into the mass by iron stirring rods, and the temperature of the mixture brought to 450 deg. F. The material must be constantly stirred to prevent burning and then removed from the kettles in all-iron wheel-barrows or oak buckets, and taken to the work as required.

"The gravel or stone must be thoroughly dry before being put into the mastic and should be clean, well-graded material, which contains no particles larger than would pass through a ¼ in. mesh.

"Native bitumens do not give as good results as do the imported mastics."

DISCUSSION.

(Subject No. 2. Floors.)

J. P. Wood (P. M. R. R.) :—I would like to ask the chairman of this committee what figures he used for sand, gravel and cement in arriving at the costs of the floors quoted in the report.

D. Rounseville :—I don't remember the prices for each kind of material. We took unit prices on floors that we had constructed at different places. We did not go into the particulars very closely because in the different locations the prices varied so much that we could not agree on a single price that would meet all conditions.

J. P. Wood :—I am under the impression that your gravel and cement cost you more than it does in Michigan as you allow $2.50 per sq. yd. for the floors put in.

D. Rounseville :—We considered the cost of the various kinds of material and allowed freight at about 75 cts. per yard.

The President :—Does this $2.50 include the filling and the preparation of the site, or just the floor on top of the previously-prepared site?

D. Rounseville :—It includes the preparation of the site and three or four feet of filling.

J. P. Wood :—I must disagree with the committee in regard to the use of the 1-in. surfaced top. We obtain better results by using more water in mixing our concrete, puddling it well and floating it without using a surfaced top. We have discontinued this latter practise on our division entirely. By floating the concrete the large aggregates are worked into the mass far enough to leave a smooth surface and at the same time the entire floor is one solid body of concrete, leaving no chance for the surface to crack and scale off as many times occurs where a surfaced top is used. My observations have been that where a surfaced top was used in roundhouses, machine shops, etc., where heavy trucking is being done, sooner or later the top will crack and scale off.

L. D. Hadwen :—Mr. Wood raised a point regarding cost. I would like to ask Mr. Rounseville if the figures for the floors in shops include the thickening for the jacking floor, with the extra concrete required, where jacking is to be done?

D. Rounseville :—Yes.

L. D. Hadwen :—We have built a number of shop floors, more particularly in paint shops, where we have torn out old plank floors and where the rubble walls of the old pits remained

in the coach stalls. Those pits are being filled and drains put down the center. In putting in floors of that kind we have to re-enforce the portion that comes immediately next to the pits and which has to carry the jacking load. We use a slight re-enforcement and make a beam floor out of it to a certain extent. All of those details add materially to the unit cost. It is not fair to consider a shop floor on the basis of a unit price per square foot unless one knows what is being done in the particular shop. I say that in explanation of the criticism made of Mr. Rounseville's figures. I can readily understand that the cost may be double the ordinary unit cost on such work.

D. Rounseville:—We did not expect those figures would fit all conditions in all places, so we simply took a certain number of buildings where floors had been constructed new and others where they had been reconstructed, struck an average and put it in this preliminary paper to bring out discussion.

The President:—Do you think that the figures for all of the different types of floors are on about the same basis so that they can be used in comparing one floor against another?

D. Rounseville:—No, sir, the difference is so great under different conditions that I would not think so.

J. P. Wood:—I am awaré that the conditions vary very much. One may put a floor in a warehouse where he has considerable filling to do, adding materially to the cost over that where one is putting a floor in a machine shop, coach house or round house where there has been a mastic or wood floor. I have in mind renewing a floor in a truck shop where the cost was materially lower than the average price quoted by Mr. Rounseville, because of the fact that there was an old mastic floor that we had to take out in excavating for the new one. However, this left us a good floor bed, that reduced the cost of the new floor materially.

The President:—Would you like to quote those figures?

J. P. Wood:—Yes. Our gravel cost us $.25 per ton at the pit and was hauled 164 miles. Cement was somewhat cheaper then than it is now as it cost us $1.35 per barrel with a rebate of $.10 for each cotton sack returned in good condition. Allowing for the transportation of the men, the haul and the cost of the material, the labor taking out the old floor and the preparation of the bed for the new floor and putting in with the necessary re-enforcement near the rails for jacking purposes, the floor cost $381

for 4200 sq. ft. or a trifle more than $.09 per sq. ft. We had nothing to do with the tie renewals as this was taken care of by the track department, but we concreted over them after they were put in.

E. C. Morrison:—We placed floors in five freight sheds, 825 ft. long by 60 ft. wide. We figured that a concrete floor, with an asphalt top, would cost 15 per cent more than wood, but we adopted the asphalt, and it has not required a cent's worth of repairs in two years. We have a roundhouse at Watsonville Jct. with a brick floor. That is an innovation with us. I am curious to know if there are any other roundhouses with brick floors in the country.

P. Aagaard:—We use nothing but brick floors in roundhouses on the Illinois Central and they are giving good satisfaction.

L. Jutton:—We have a good many brick floors in roundhouses on the Northwestern; including some that were put in about five years ago. There has been very little maintenance on them. We have had occasion to do some work on the sewer in one house and we were very glad that we had a brick floor to deal with instead of a concrete floor when getting at our sewers. When you put in a concrete floor you have to put joints in, and everytime you put a joint in such a floor you have something that is going to wear. I think that is something that ought to be considered in designing a floor. You should figure what you have under it, and the liability of having to dig into it some time and to fix whatever is under it. Of course if one don't have to dig under it, conditions will be different.

W. M. Clark:—We have a brick roundhouse floor on the division that I am on, that was laid in 1903. Other people may have had luck with them but we have not. We have one roundhouse that we refloored this summer, in which we put plank flooring. As this was a place where heavy repairs for locomotives were made, it was decided after a conference that neither a concreted block nor a brick floor would stand the abuse, so we floored it with 3-inch oak. I think the ideal floor is creosoted blocks on a concrete base, with one half an inch to an inch of sand between. We had one such floor in a freight house in which we handle, I believe, about 60 cars of transfer freight per day. This floor has been in use for the last seven years and there has not been a cent of repair on it. We have other freight house floors of this type that have not been used as extensively, and

one cannot tell any difference at all. No wear is evident. However I don't think creosoted blocks should be laid on anything but a concrete base, that will hold up the floor. Some have said that they have had very good success with maple. We have had several maple floors that we did not have any trouble with on the top side, but we did have trouble with the bottom side, rotting from below. At others we have had no trouble. My experience is that maple will not stand in a floor that is not perfectly ventilated, to keep the dampness from the underside of the material.

Jos. Spencer:—Last winter we built a yellow pine creosoted block floor in an erecting locomotive shop which had an area of 42,000 sq. ft. In one portion of it we made a bed consisting of about 10 in. of coarse gravel with a top dressing of one inch of sand upon which the blocks were laid. We sifted dry sand over the blocks to fill all cracks, but we found that the sand would wash down and puddle where water was used for washing out boilers.

The remainder of the floor was laid upon a filling of cinders well pounded and rolled, having a top dressing of sand 1 in. deep. This was found to be far superior to the gravel filling.

A concrete base costs more but makes a far more durable floor.

E. T. Howson:—One thing that Mr. Clark referred to deserves particular emphasis,—that is the question of the foundation. I believe as many floors go down from defective foundations as from defective wearing surfaces. Manufacturers of concrete, brick, creosoted block and other flooring materials state that many railroad men do not realize the importance of a good foundation. I know of three or four orders for materials that have been turned down because the company did not feel that it could risk the danger of a failure of its product, where the road was not willing to put in a proper foundation. With a floor such as brick or creosoted block, built in small units, one is very apt to encounter settlement, leading to early failure, if he don't have a firm foundation to support it. If one provides a firm foundation he can get almost indefinite wear.

There is one modification of the types of freight house floors that the committee call attention to, that is being used in a number of instances with excellent satisfaction; that is the placing of steel plates in the runways over the ordinary wooden floor, particularly after the wooden floor has begun to go down. It increases the ease of trucking, with less danger of packages falling off and being broken. The question of breakage of freight handled in a

freight house brings up a point with reference to concrete floors. Concrete, or any other rigid floors are likely to cause an increased amount of claims from breakage when articles fall on the floor.

J. B. Sheldon:—I would like to learn the experience of the members with trucking with the iron tired truck over concrete floors. How much trouble has been encountered on account of holes being gouged out? Our experience has not been good.

L. D. Hadwen:—We have used a good many concrete floors in freight houses and I can't say that we have experienced much trouble. The objection to the floor has been rather on the part of the men who do the trucking—in damage to freight and so on. It is not a question of the wear of the floor.

Maro Johnson:—The Illinois Central has several large warehouses about four blocks down the street which have concrete floors.

The President:—One phase of this subject that has hardly been touched on, is the putting of a mastic asphalt covering on top of a worn wooden floor.

J. Gratto:—The floors of some of the wharves in Southern California became so badly worn that they required repairs. We left the rough plank floors in and added a covering of asphalt mastic. Some of these floors have been in use for several years and I am of the opinion that they are good for many years to come. In regard to roundhouse floors, I claim that creosoted block is the only floor if built right. We have such floors built in 1900 on which we have never spent a dollar since. In our big terminal stations we use cedar blocks. The men truck the loads and don't drop much freight. I claim that creosoted blocks are the right thing in a roundhouse. Bed them in sand and they will stay there.

The President:—I would like to enlarge a little on the wharf situation. We had a long wharf of the plank type at San Pedro at which the lumber vessels come in and unload. It is customary to unload the lumber on sling loads, onto two-horse trucks. The wheels of these trucks are about 24 in. in diameter and they wear the plank top off the wharf in about three months, so it can not be used any longer, for they would upset on the wharf, and there is no power to load the timber again, after they get away from the ship's rigging. We had to try to prevent the tipping of the loads. We put an asphalt floor on top of the worn pavement, in

a section of wharf with a creosoted plank deck. After this was put on vessels would wait two or three days to get a chance to load on this piece of asphalted deck. It has been there 12 years and there has been no change in the planking underneath it, because the deck was thoroughly waterproofed. After having experience with the first section we put on another section that has given equal satisfaction. It is my understanding that the second section only cost about $0.09½ per sq. ft. Nothing was done with the original planking which was worn and rough, with knot holes in it. We have about 9,000,000 square feet of wharf and we are going to put that surface on all of it. This is what we call asphaltic macadam with asphalt and rock mixed up together and rolled down. It is the same substance from top to bottom, except that a thick coating of asphaltum cement is placed on top.

J. G. Robinson:—I was discussing this subject with our general superintendent of motive power a short time ago and he said that asphalt or concrete makes an ideal floor but that the ordinary plank flooring on concrete makes a very poor floor. I reminded him of a maple floor laid on concrete in one of our freight houses in 1897, where heavy trucking is done and which is still in good condition. He admitted that a floor of that kind was all right for warehouses and freight houses but not for shops. He considered 2 in. of asphalt on 6 in. of concrete an ideal floor for shops.

B. F. Pickering:—I would like to ask if you think that an asphalt covering on a wooden transfer platform, where freight trucks are used extensively and with heavy loads, would work out equally as well as it has on your wharf where you use larger wheels? Wouldn't it soften up enough to make a truck with a small wheel go hard with a man pulling a heavy load?

The President:—I don't imagine a small wheel is any harder on it, in proportion than a large wheel. You might experience some difficulty in having the mastic properly applied to suit the various temperatures you have to contend with. Only certain firms are able to apply it successfully.

B. F. Pickering:—We have a large transfer point at which we have four platforms about 800 ft. long. We had 600 men employed at that point and the planking got so rough that we had difficulty in keeping them. Mr. Howson suggested iron strips. That did not seem feasible, and I myself suggested the asphalt top, but I was overruled, as the superintendent said that it would soften so much that he couldn't get any men to walk on it. How-

ever, we have re-planked the worn top with two-inch oak running diagonally across the platform and we are getting better results, but I am anxious to know what the results would be with the asphalt top.

The President:—I am certain that, if it were our road, we would put on 100 ft. of it and try it at once.

B. F. Gehr:—We have three double freight houses, in which we have placed metal strips 10 in. wide and 10 in. apart. We find they are successful in saving plank and they furnish a smooth surface for trucking, saving a great many claims. The freight house men like them and I can recommend them highly.

G. T. Sampson:—I have had considerable to do with laying floors in freight houses. We used creosoted lumber in the floors of our three pier sheds on the South Boston freight terminal. In the floor of our Pier No. 2 shed, 200 ft. wide and 575 ft. long, we used a layer of 3-in. creosoted hemlock plank for under floor directly, on gravel, having first bedded in the gravel lines of 3 x 8 in. creosoted hemlock mud sills with their tops even with the gravel surface and spaced 4 ft. apart. This floor of 3-in. creosoted hemlock was laid at right angles with the mud sills and spiked to them, and above that we laid a top wearing surface of untreated 2-in. spruce plank. These creosoted sills embedded in the gravel in 1881 are still doing service. This testifies in a decisive and convincing manner to the wisdom of creosoting material. This plank came by water in schooners from Maine and cost about $12.50 per M, and cost about the same price for creosoting.

Our No. 7 outward freight house at South Boston, built in 1898, is 30 ft. wide and has 26 bays of 15 ft. each. The floor is supported on a 10" x 14" hard pine cross-girder 30 ft. long resting on 4 masonry piers for each bay. The space of 15 ft. between each cross-girder is spanned by 3" x 12" hard pine floor joists spaced about 18 in. on centers and resting on top of the girders; the floor surface is about 3½ to 4 ft. above the surface of the paved driveway. The floor is laid direct on top of the 3" x 12" joists with an under layer of 2-in. spruce plank, surfaced on one side, and on top of that is a floor of thoroughly seasoned 1¼ in. by 3½-in. tongued and grooved hard maple, backed out on the under side and blind-fastened. This floor is in good order today after being trucked over constantly by heavy traffic, which is an evidence that maple makes a durable and economical floor. It is so hard and smooth that trucking labor is reduced to a minimum. The only repairs nec-

essary up to the present time have been in the vicinity of the doors.

About 1906 we laid other floors in brick freight houses using concrete slabs of granolithic crushed stone and cement, without sand or gravel bedding for foundation. Preliminary to laying this floor we kept the gravel bed saturated and puddled with water expecting to avoid settlement but did not succeed in that respect. The slabs have settled somewhat irregularly, yet the wearing surface is pretty good. It has not deteriorated to the extent of being unfit for service, but the worst and unavoidable defect of a granolithic floor is the moisture from condensation at times of sudden changes of temperature.

J. S. Robinson:—I would like to ask what the difference in temperature is in the docks or freight houses where mastic is used. I understand that in California there is only about 30 deg. difference, while we have about 70 deg. difference. That makes considerable difference in the mastic laid in a dock or freight house.

The President:—I think we are safe in saying that it ranges from 35 deg. to 105 deg. We also put that type of floor on a highway bridge about 800 ft. long and 25 ft. wide, on a concrete base, using exactly the same mixture of mastic. The temperature will get down to 30 deg. and up as high as 116. The bridge at Sacramento is subjected to all kinds of traffic loads. That floor is as good now as the day it was put on, five years ago. I examined it within a month and I failed to find the slightest wear on it.

A. S. Markley:—The durability of timber depends altogether on its protection from dampness from the ground as well as from other elements with which it may come in contact. The C. & E. I. built new shops at Oaklawn in 1903. The machine shop and the boiler shop floors were constructed of a coating of well mixed hot asphalt and hot sand upon which was laid a 3-in. common pine plank floor and on this a 1½-in. thickness of butt joint maple flooring,—the grain of both layers running in the same direction. Extensive repairs were made to these floors in 1912, when it was found that the layer of asphalt had cracked in places, permitting dampness to come in contact with the wood where it decayed so badly that it could be picked out with one's hands or a shovel. Where the asphalt did not crack the timber was in good condition except where water from the boilers was permitted to run on the floor which caused the maple flooring to decay.

Material for floors in this class of buildings should be damp-

and water-proof. We have therefore considered the matter of renewing the floor in the boiler shop with shale brick, laid on stone dust and very fine limestone screenings to a depth of 6 in., which would cost about $2.65 per sq. yd. (including the removal of the old floor). While good foundations are necessary in all cases the stone dust and screenings will answer its purpose in this case fully as well as if built of concrete. A sand filling would also answer the purpose if the joints in the brick were filled with cement to keep the water from getting into the sand.

When our roundhouse at Yard Center (16 miles from Chicago) was erected in 1900 the concrete engine pits were built on from 1 to 3 ft. of sand filling. The sand foundation stood the test all these years, except where the concrete in one of the pits cracked allowing water to get through, where settlement occurred.

Mr. Wood quotes 9 ct. per sq. ft. for concrete floor, which is very cheap, and of course the coat depends on local conditions and quantity of material used.

Subject No. 3.

PAINT AND ITS APPLICATION TO RAILWAY STRUCTURES.

REPORT OF COMMITTEE.

Through a misunderstanding on the part of the chairman as to the personnel of this committee this can not be considered in the form of a committee report, but as the chairman had done considerable work on the subject, the information is published here for the benefit of the members.

As so much investigational and experimental work has been done on this subject it was considered preferable to compile the best information to date than to undertake an independent investigation.

There are two important phases of the subject: First and most important is the question of the materials to use and the methods of application to follow in the protection of structures as we find them. Next in importance, and really of relatively greater importance to the parts affected than the materials and methods of application, is the question of design as related to the protection of the structure.

Paint Materials.

The report of the committee on Iron and Steel Structures of the American Railway Engineering Association in 1914, gives such an excellent digest and analysis of the pigments and vehicles ordinarily used in paints that it is reprinted here for ready reference:—

"Pigments may, in respect to their action upon steel in water, be divided into three classes, each of which merges into the next by easy steps, so that the line of demarcation is difficult to ascertain. These classes are the 'inhibitive,' the 'neutral' (inerts or indeterminate), and the 'stimulative.' The 'inhibitive' pigments retard rust, the 'stimulative,' hasten corrosion, while the 'inerts' are an intermediate class which apparently leave the material in much the same condition as it was originally, the only protective action being that of a covering pure and simple. It should be noted that the chemical composition of the metal influences the action of the pigment and may reduce the protective action of weak inhibitors.

"Pigments may further be divided according to their ability to exclude and shed moisture. There is a distinction between the two classes mentioned. A pigment may exclude the moisture and still be of such a surface character as to allow it to stand upon the surface until it evaporates or is absorbed; or a pigment may have such surface characteristics that the moisture will run off. A 'shedding' pigment may be a greater absorber of moisture than an 'excluder' and still be a superior protection, according to the conditions of location.

"Strong inhibitors may be weak 'excluders' or 'shedders,' while 'stimulators' may have high qualities as 'excluders' or 'shedders.'

"Pigments may have different coefficients of expansion and 'drying' and different moduli of elasticity. In cases where great differences obtain in any or all of these properties, the surface may 'alligator' or crack. In some cases the finishing coat has 'alligatored' along the priming coat, which was of a different color, and this shows through. The liability of some of the best 'inhibitors' to crack or alligator is so great as to preclude their use in many cases.

"The chemical processes by which the pigments are prepared exert a marked influence in the action of the pigment on the metal. For example, Prussian blue may be either inhibitive, neutral or stimulative, according to the process of manufacture. This condition of affairs probably serves as a basis for discussion where one person condemns and another lauds a certain pigment used in different cases under the same conditions. Failure occurred in one case, and fair satisfaction was given in the other.

"The consideration of the conditions of exposure are also important in the selection of a pigment. The chemical composition of the pigment may be affected by either heat, light, moisture or gases, so that it would fail, whereas if one or more of these deteriorating influences was absent, good service would be obtained.

"The vehicle is as important as the base. While the vehicle may, on account of porosity or other features, be objectionable, yet the addition of the pigment will, by reason of the filling of the voids, produce a successful protective coating.

"Investigators have concluded that the size of the pigment particles is important and that the law of minimum voids holds true in the preparation of protective coatings, as well as in concrete. Therefore, either various proportions of the same pigment, which have different degrees of fineness, or the mixing of pigments of different degrees of fineness, would seem to be advisable. The spreading value of a pigment is an important consideration, secondary, of course, to its protective action, but still influencing it. Too high a spreading quality causes films of paint too thin to withstand the actions of the deteriorating influences.

"Investigators appear to have come to the conclusion that bituminous coatings protect metal better than any other, but that the action of sunlight readily destroys their life and, hence, the value, and that, therefore, they are practically of no value as a protective agent where subjected to the action of light.

"From the preceding it appears that:

(1) Priming coats should always be inhibitors, whether or not they are excluders or shedders.

(2) Finishing coats should be excluders or shedders; shedders, preferably, whether or not they are inhibitors, neutrals or stimulators.

(3) Care must be taken to consider the deteriorating influence and determine the chemical requirements of the pigment accordingly.

(4) In cases where a pigment appears in more than one class, care should be taken to determine its process of manufacture before using it as a priming coat.

(5) That the best results will probably be obtained by using an 'inhibitive' and 'excluder' or 'shedder' pigment for both priming and finishing coats, due consideration being paid to (3).

Table 1 gives the classes to which commonly-used pigments belong:

Table I—Classification of Pigments (Cushman).

Inhibitors	Indeterminates	Stimulators
Zinc and Lead Chromate	White Lead (Quick Process, Basis Carbonate)	Lamp-black
Zinc Oxide	Sublimed White Lead (Basic Sulphate)	Precipitated Barium Sulphate (Blanc Fixe)
Zinc Chromate	Sublimed Blue Lead	Ochre
Zinc and Barium Chromate	Lithopone	Bridge Red Oxide
Zinc Lead White	Orange Mineral (American Red Lead)	Carbon Black
Prussian Blue (inhibitive)	Litharge	Graphite No. 2
Chrome Green (Blue tone)	Venetian Red	Barium Sulphate (Barytes)
White Lead (Dutch process)	Prince's Metallic Brown	Graphite No. 1
Ultramarine Blue	Calcium Carbonate (Whiting)	Prussian Blue (Stimulative)
Willow Charcoal	Calcium Carbonate (Precipitated)	Linseed Oil
	Calcium Sulphate	
	China Clay	
	Asbestine	
	American Vermilion	
	Medium Chrome Yellow	

"From this it is seen that the carbon and graphite paints should not be used as primers, that the zinc and zinc lead pigments are good primers, while the lead basis may belong to either class, according to their method of manufacture.

"Table 2 gives the relative moisture value of pigments (Cushman)

Table II—Moisture Experiments.

Experiments Given Express Gain in Weight, e. g., Water Absorbed.

Rank.	Pigment.	Relative Units Absorbed in 7 Days.
1	Iron Oxides (with 2 per cent. Zinc Chromate and 2 per cent Gum)	0.032
2	White Lead, D. D.	0.040
3	White Lead and Zinc Oxide	0.043
4	China Clay	0.044
5	Whiting	0.044
6	Zinc Oxide, Barytes and Blanc Fixe.	0.048
7	Zinc Lead White	0.049
8	Red Lead	0.049
9	Basic Sulphate—White Lead	0.049
10	Zinc Oxide and Whiting	0.060
11	Zinc Chromate	0.064
12	Barytes and Zinc Oxide	0.064
13	Zinc Oxide	0.065
14	Calcium Sulphate	0.066
15	American Vermilion	0.069
16	White Lead, Barytes and Blanc Fixe.	0.074
17	Barytes	0.074
18	Willow Charcoal	0.077
19	Lithopone	0.083
20	Carbon Black	0.084
21	Lead and Zinc Chromate	0.086
22	Chinese Blue (Stimulative)	0.092
23	Venetian Red	0.093
24	Natural Graphite	0.104
25	Medium Chrome Yellow	0.106
26	Bright Red Oxide	0.116
27	Barium and Zinc Chromate	0.116
28	Ultramarine	0.119
29	Prussian Blue (Inhibitive)	0.125
30	Raw Linseed Oil	0.143
31	Lamp-black	0.199
32	Blanc Fixe	0.210

"It shows that some of the best inhibitors are in the lowest 'excluder' coefficient, and vice versa—although some of the best inhibitors are the best excluders.

"It is of particular interest to note that raw linseed oil alone stands 30 in a list of 32, being one of the worst excluders. This alone should be sufficient to remove it for the priming coatings and all experiments appear to show that, as a primer coating, it is also one of the greatest stimulators."

The Proceedings of the American Society for Testing Materials are so replete with information giving the results of exhaustive investigations into this subject that it is thought advisable to give a brief synopsis of the results accomplished:

"The matter was first taken up by the American Society for Testing Materials at its fifth annual meeting in 1902, at which time a resolution was adopted to appoint a committee on 'Preservative Coatings for Iron and Steel.' The first report was made by that committee in 1903. and beginning with that year the Proceedings contain a great deal of valuable information in committee reports and in papers by individual members.

"The committee early realized the desirability of service tests on full-sized structures in ordinary service, and made such a recommendation in 1903. The report of that year gave the general requirements as a basis for the work of the committee:

(1) Requirements for a satisfactory preservative metal coating.

(2) Methods used and suggested to determine whether the preservative coating is efficient.

(3) An index, with abstracts if possible, of general and current literature bearing on this subject which has appeared in English, French, German and American publications.

(4) A classified list of all coatings used or suggested for the protection of iron and steel.

"In addition, the committee recommended a series of tests on steel panels, and in 1904 reported in detail the methods of preparing such panels for test.

"In 1906 the committee reported that arrangements were under way to paint a portion of the Havre de Grace bridge of the Pennsylvania Railroad with a large number of different brands and kinds of paints, one portion of the bridge and several sheets of steel to be painted with each paint.

"In 1907 the committee reported that 19 paints had been applied to 19 panels of the bridge. Specifications for the preparation of the surface and application of the paint were as follows:—

(1) The surface of all accessible metal, in so far as is practicable is to be cleaned in a workmanlike manner with putty and broad knives, scraper and wire brushes, so that all loose or easily detachable mill scale rust and dirt are removed, as well as loose shop coat or 'black oil' (by 'black oil' is meant linseed). Any non-drying oil or grease on accessible parts is to be removed with either benzine or a torch.

(2) Where the shop coat is firm, hard, and in good condition, it is not necessary to remove it. This applies also to black oil.

(3) Field and shop rivets are to be wire-brushed, and, where necessary, this is to be followed by the knife or scraper, and hammer is not to be used.

(4) It is understood that the inside of columns and such other members difficult of access are not to enter into the test, and the above instructions for cleaning do not apply to them. They should, however, be cleaned in accordance with the ordinary methods of the contractor. The inspector is to make note of such members and include them in his report.

(5) Painting should follow cleaning immediately, and as many different paints are to be applied at the same time as the length and position of the scaffolds and expediency will permit.

(6) No paint shall be applied when the humidity is greater than 85 per cent.

(7) Since the net cost of all work is borne by the committee, the inspector will see that the work is done with reasonable promptness, and will endeavor to keep the cost down as much as possible, consistent with reasonable thoroughness.

"The committee also adopted the following rules for

"METHOD OF INSPECTION OF CONDITION OF PAINTS UPON HAVRE DE GRACE BRIDGE

(1) Inspection to be made every six months, unless for sufficient reasons the committee desires more frequent inspections, by an official inspector. Notice of each inspection is to be sent out previously to every member of the committee, with the endeavor to have the committee represented at each inspection.

(2) As far as practicable, a photograph should be taken at each inspection by a thoroughly competent photographer, preferably the inspector, care being taken to obtain negatives capable of enlargement and microscopic examination. A scale should be photographed in connection with the object.

(3) Character of gloss, to be noted by the inspector, whether high, moderate, dull or flat.

(4) Relative absorptive condition of each film when moistened with water.

(5) Relative toughness to be determined by cutting the film with a sharp knife, note being made whether elastic, tough, brittle or flaking, degree of adhesion being determined by the same test.

(6) Condition of surface to be noted, whether tendency to blister, alligator, scale, flake or powder (chalk), giving especial attention to the condition at angles and corners.

(7) Relative hardness to be determined by testing the films as to resistance to an edge of a cube of lead, tin, aluminum and zinc, respectively. (The details are now being worked out by Mr. Heckel, and report upon the method will be made shortly.)

(8) Note to be made as to the degree to which dirt has become attached to the surface.

(9) Condition of the surface as to powdering and general appearance, wear and weathering.

(10) When pitting has begun, the size, number, form, character and location of the pimple should be clearly noted. and the proportional increase since last inspection.

(11) Date to be noted on which repainting becomes necessary.

(12) These instructions are intended merely as a general guide to the inspector, who will be expected to make as complete observations as possible of all matters which appear to him to be worthy of report.

The 1908 report stated 'The only example of an asphaltum coating thinned with a petroleum volatile solvent has failed to a marked degree after 18 months' exposure.'

"In 1911, with one or two exceptions, the paints were affording excellent protection to the structure.

"In 1908 a number of paints were also applied to wooden and steel panels exposed to the salt air at Atlantic City, N. J. The description of these tests is contained in Vol. X, 1910, pages 79 et seq., Pro. Amer. Soc. Testing Materials.

"Some of the facts of interest set forth in the proceedings are as follows:—

"Almost no paint containing linseed oil as a constituent is impervious to water. The fineness of the pigment is a most important element in the water resistance of the layer. Protective coatings which dry by evaporation of the solvent seem to offer much more prospect of success. If our experiments are to be trusted, the protective coatings at present available are not as valuable as we have been hoping." Dudley, Vol. IV, 1904.

"Cement coatings must be kept in moist air at least 24 hours after being applied. Cement in extremely fine state of division will be necessary: 5 to 10 per cent calcium chloride makes it set before drying." Newberry, Vol. IV, 1904.

"Paint must be rubbed in with a good stiff round brush. Proper cleaning and proper application of primary importance. Average quality of wood painting better than iron. Paint, then cover with paraffin paper, then paint." Sabin, Vol. IV, 1904.

"Tar residuum of petroleum mixed with some of the lighter oils (petroleum products) is the best preservative for train shed steel." De Wyrall, Vol. IV, 1904.

"Some of the ferric oxides are perfectly stable, are not affected by gases, and cannot change their composition." Toch, Vol. V, 1905.

"Use of flat brush should be prohibited. Round brush larger than a 6-0 should not be allowed." Cheesman, Vol. V, 1905.

"In addition to the committee reports, articles contained in the proceedings of the American Society for Testing Materials referring to preservative coatings for Iron & Steel are as follows:—

Volume IV-1904.

Results of an Investigation Concerning Causes of Durability of Paints for Structural Work.—Robert Job.

Preservative Coatings for Iron and Steel.—Cyril de Wyrall.

Volume V—1905.
- Proper Methods in Conducting Painting Tests:—G. W. Thompson.
- The Practicability of Establishing Standard Specifications for Preservative Coatings for Steel.—Topical Discussion.
- Protection of Iron and Steel Structures by Means of Paper and Paint.—Louis H. Barker.
- What is the Best Method of Painting Cars?—Frank P. Cheesman.
- The Effect of Electricity on Paint.—James C. Blanch.

Volume VI—1906.
- The Electrolytic Corrosion of Structural Steel.—Max Toch.
- The Relative Corrision of Wrought-Iron and Steel.—H. M. Howe.
- The Corrosion of Iron and Steel.—General Discussion.

Volume VII—1907.
- The Corrosion of Iron.—Allerton S. Cushman.
- The Influence of Stress upon Corrosion of Iron.—W. H. Walker, and Colby Dill.
- Priming Coats for Metal Surfaces.—Linseed Oil vs. Paint.—F. P. Cheesman.
- Deleterious Ingredients in Paints.—L. S. Hughes.
- Physical Testing of Oil Varnishes.—L. S. Hughes.
- The Physical Properties of Paint Films.—R. S. Perry.
- Paint Legislation.—E. F. Ladd.

Volume VIII—1908.
- Electrolysis and Corrosion.—A. S. Cushman.
- The Relative Corrosion of Steel and Wrought-Iron Tubing.—H. M. Howe and Bradley Stoughton.
- General Discussion on Corrosion.
- The Analysis of Oil Varnishes.—P. C. McIlhiney.
- Certain Solubility Tests on Protective Coatings.—G. W. Thompson.
- The Inhibitive Power of Certain Pigments on the Corrosion of Iron and Steel.—A. S. Cushman.

Volume X—1910.
- Some Exposure Tests of Structural Steel Coatings.—C. M. Chapman.
- Vermilion Paint for Railway Signals: Results of an Investigation.—Robert Job.
- Another Solubility Test on Protective Coatings.—G. W. Thompson.

Volume XI—1911.
- Analysis of Results of Official Inspection of Fence Wire Tests, Carnegie Technical Schools, Pittsburgh, Pa., Nov. 30, 1910.
- The Value of the Sulphuric Acid Corrosion Test.—C. M. Chapman.
- The Marked Influence of Copper in Iron and Steel on the Acid Corrosion Test.—W. H. Walker.
- Some Tests on the Rate of Corrosion of Metal Exposed to Locomotive Gases.—A. W. Carpenter.

Volume XIII—1913.
- Standard Specifications for the Purity of Raw Linseed Oil from North American Seed.
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Paints for Metallic Structures.—Alberton S. Cushman.
Notes on the Testing of Anti-Corrosion Paints.—P. Labordere and F. Anstett.
The Volume Conception in the Testing of Paint Materials.—Gustave W. Thompson."

The available information pertaining to steel structures was so well collated in the 1915 report of the committee on Iron and Steel Structures of the American Railway Engineering Association that the pertinent part of the report is reprinted here for ready reference.

"STUDY OF PRINCIPLES UNDERLYING THE CHOICE OF MATERIALS FOR EFFICIENT PAINTS.

"Paints for the protection of iron and steel structures may be simple liquids, as drying oils; dissolved solids, as asphalt paints and coal tar paints; combinations of pulverized or finely-divided solids, known as pigments, and of drying oils, known as vehicles; and lastly almost any combination of any of the above. (Technically, there may be some question as to calling a simple drying oil a paint, but when used as a coating it is merely an extreme case.) Varnishes, which are mixtures of gums and oils, compounded by means of heat, are frequently introduced into the vehicles of paints.

"The most important and extensively used paints are those which are mechanical mixtures of pigments and vehicles. The most important and common vehicle is linseed oil. Other vehicles are fish oils, china wood oil, soya bean oil and mineral oils. All of these except china wood oil have been frequently used as cheap and inferior substitutes for adulterants of linseed oil, although china wood oil, soya bean oil and menhaden (fish) oil are recognized as valuable assistants in certain paints. Turpentine and light mineral oils (such as benzine, benzol, naphtha, etc.) are used as thinners and solvents and are so used both legitimately and otherwise.

"An oil paint generally requires, in addition to the pigment and the oil, a small proportion of dryer, which is generally a liquid which, when incorporated into the paint, causes the film of it to dry by oxidation with the desired rapidity. Films of other paints, such as asphaltum and coal tar paints dry by the evaporation of the solvent.

"It is quite generally considered that the most durable paints are those which are composed of pigments with linseed oil as the principal ingredient of the vehicle. Linseed oil varies in its composition and properties according to its method of extraction from the flaxseed, and its later manipulation. There is little or no choice nowadays to the consumer as regards method of extraction from the seed, this being controlled by large commercial concerns whose methods are practically identical in that they all employ the hot-pressed method which possibly gives inferior oil to that obtained by the cold-pressed method. After pressing, however, the oil is processed and refined by many methods and graded commercially accordingly. Raw oil and boiled oil are the two general kinds employed for structural metal paints and both of these are variously treated so as to considerably modify their properties.

"Raw oil with drier added to it without heating has been sold as boiled oil—'bung-hole' boiled or 'chemically' boiled by those who understand the difference between this makeshift and true boiled oil which is heated to a relatively high temperature, and generally has driers added also. When heated in open kettles, which is generally con-

sidered the best method, it is called open-kettle boiled and there is supposed to be some virtue in having the heat applied by means of a wood fire under the kettle.

"There is room for much difference in treatment and skill in manipulation in boiling oil by the heating process and this leads to many claims of superiority by different paint manufacturers for their particular and secret methods in this line. Just how much if any real superiority there is in these special-processed oils over the commercial open-kettle boiled now readily obtainable of the large oil manufacturers, is difficult to prove or disprove. It is generally conceded that either raw or boiled linseed should be free from certain ordinary impurities in order to give the best results in paints. There is a great difference of opinion as to the merits of raw or boiled oil for paint-making purposes, but for metal paints the tendency seems to be towards the use of the open-kettle boiled oil.

"As films of linseed oil-and-pigment are always more or less porous and pervious to water and moisture, considerable experimentation has been undertaken towards increasing the impermeability of the film by adding varnishes, bitumens and other kinds of oils to the linseed oil in certain minor proportions. If the proportions of these added materials become too great, the durability of the film is generally decreased on account of brittleness or otherwise.

"The importance of the quality and proportions of driers is recognized, but these have apparently not as yet been the subject of any such extensive study as have oils and pigments.

"The most extensive scientific study of the properties of paint materials probably has been made on pigments. For a long time paints have been principally known to engineers and others simply by the name of the pigment element, as iron oxide paint, red lead paint, graphite paint, etc., and it was long supposed that the pigment was the principal factor in determining the efficiency of these paints.

"Pigments are commonly divided into two general classes, which may be called primary and secondary. Those in the primary class are the ones strong in color or in covering power and sometimes forming chemical combinations with the vehicles. Those of the secondary class are weak in color and covering, generally not suitable for use alone as pigments, but suitable as fillers and extenders when mixed with these primary pigments: these are commonly known as 'inert' pigments, although this is really a bad designation, since many of the primary pigments are chemically inert to all atmospheric influences and to the usual paint vehicles.

"The principal primary pigments used for structural metal paints are the following:—

1. White leads.
   (a) The basic carbonate, which is the kind made by the well-known Dutch process, and (b) the basic sulphate, commonly known as the 'sublimed' variety.
2. Zinc oxide or white zinc.
3. Red lead.
4. Blue lead.
5. Iron oxides, including Venetian red.
6. Lampblacks, generally the product of burned petroleum oils.
7. Carbon blacks, generally product of burned natural gas.
8. Graphites, natural and artificial.
9. Ochres.
10. Natural carbon, slates, clays, etc., possessing peculiar properties fitting them for pigments.
11. Chrome greens and yellows, used generally for tinting only.

"The cost of the above pigments will usually range from 2 cents to 10 cents per pound, except the chrome pigments which, when pure, are much more expensive. Pigments which are sometimes used, but are

generally prohibitory on account of their high cost, are American Vermilion and other chromates and Prussian Blue.

"The principal secondary pigments are:—

1. Silica.
2. Asbestine.
3. Barytes (natural sulphate of barium).
4. Calcium carbonate, including chalks (frequently called whiting).
5. Clays.
6. Gypsum.
7. Blanc fixe (artificial sulphate of barium).

"These are all cheap materials, usually costing under 2 cents per pound. When used they are mixed with the primary pigments to cheapen the product and often with definite ideas of improvement of the paint. For instance, a small percentage of calcium carbonate is said to counteract any free acid that may be in the primary pigment; silica is thought by some to give a "tooth" for holding subsequent coats; asbestine and china clay aid in keeping pigments in suspension in the vehicles; barytes gives weight and body to paint; blanc fixe, used in large proportions in proper mixtures, is said to give excellent results for certain sea air exposures.

"As before mentioned it has for many years been generally thought that the pigment is the ingredient which has the greatest influence on the durability and efficiency of paint coatings, especially those for the protection of steel surfaces, although paint technologists recognize the great importance of the vehicle and that the two must largely be considered together. So many pigments have been available and in so many variations and combinations that it has not been easy to determine their relative merits nor the properties which are necessary for suitable pigments. The question of color often is the determining factor, especially when white and very light shades of color are wanted, for which the white leads and zincs must be used; but for dark colors almost any of the pigments can be used, tinting as required, even the white pigments. (It may surprise some to know that a black pigment can be produced by mixing 45 parts by weight, of white lead and 55 parts of carbon black). Excepting the question of color, the present field of pigments may be said to be the survival of those found fittest by many years of trial. To further determine the relative merits of these pigments, many tests have been made by individuals, paint manufacturers, railroad companies, technical associations, and others, with coatings made with various pigments, applied both to test plates and to structures in service, exposed to various atmospheric influences and to artificial substitutes for them, and except for certain special conditions of application and exposure, without decisive results. Probably the most prominent of these tests are those of the American Society for Testing Materials and widely known as the Atlantic City and Havre de Grace Bridge tests. As these tests were announced as concluded this year (1914) it seems proper to present the results to the Association.

"THE ATLANTIC CITY TESTS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS.

"These were primarily paint tests of pigments mixed with oil vehicles, were inaugurated in 1908 and completed in 1914. They were undertaken mainly for a comparison with the water-test classification of pigments as 'inhibitive,' 'indeterminate' and 'stimulative.' There was also a suggestion that 'slightly soluble chromates should exert a protective action when employed as pigments, by maintaining the surface of the iron in a passive condition in case water and oxygen penetrated the paint film.' Some 50 single pigments were incorporated with linseed oil into paints which were applied in three coats to steel plates 24 in. x 36 in. in surface dimensions, in series of three plates each, one

of open-hearth steel, one of Bessemer steel and one of a special pure 'iron.' The plates were exposed to the weather at Atlantic City, N. J., and were examined annually and reported in 1910 and annually thereafter by a committee of the American Society for Testing Materials. With a few exceptions the coatings had so nearly failed at the time of the 1914 examination that it was decided that no further examination would be reported. At the American Society for Testing Materials Annual meeting in 1914, Mr. G. W. Thompson, who originally suggested the water test, expressed his opinion that it had failed to establish itself, as shown by the Atlantic City tests, as a reliable indicator of the value of pigments in oil paints for steel protection. Among the coatings which, according to the American Society for Testing Materials Committee report, proved most efficient to the last, were some of those made with pigments grouped in each of the three classes: 'inhibitive,' 'indeterminate' and 'stimulative.' It is notable that the coatings made with all of the primary pigments, Nos. 1 to 9 as listed above, with the exception of the basic carbonate-white leads and the zinc-oxide, were included in the list selected as being in proper condition for continuance of the test at the annual inspection of 1913. At that time the coatings made with the following single pigments were rejected as unsuitable for further test:

Basic carbonate-white leads (classified as "inhibitive" and "indeterminate").

Zinc oxide (classified as "inhibitive").

All secondary pigments (classified as "indeterminate" except one "stimulative").

Prussian blue (classified as "inhibitive").

Ultramarine blue (classified as "inhibitive").

"Some of the mixed-pigment coatings which the American Society for Testing Materials committee judged among the best of all the remaining coatings left in July, 1914, had the following pigment compositions:

Carbon black and barytes (both classified as "stimulative").

Lampblack, graphite and barytes (all classified as "stimulative").

"Equally notable with the above is the fact that all of the six coatings made with single chromic and chromate pigments were among those that gave the very best results. Four of these pigments were classed 'inhibitive,' two as 'indeterminate.' They would probably all be considered too expensive for general paints, costing usually from 12 cents to 20 cents per lb. There were other single pigments, including several ordinary kinds, that gave generally as good results as the chromates, these being classified indiscriminately as regards the water test. Small admixtures of chromate pigments with 'stimulative,' 'indeterminate' and weakly 'inhibitive' pigments gave no results indicating any value of such additions. It is also notable that reliable observers report that there was no appreciable average difference in the corrosion of the plates of the different kinds of steel and to the special 'iron' nor in the relative condition of the coatings protecting them.

"While the general conclusions of the A. S. T. M. Committee on these tests have not yet been published, it would seem that the results so far published quite clearly demonstrate that the tests do not follow the results of the water-test classification in determining the value of pigments when used in oil paints for the protection of metal.

"THE HAVRE DE GRACE BRIDGE TEST OF THE AMERICAN SOCIETY FOR TESTING MATERIALS.

"The Havre de Grace test, was a combination test-plate and service test located on the deck truss bridge of the Pennsylvania Railroad over the Susquehanna River at Havre de Grace, Md. Nineteen different commercial steel-protective paints furnished by sixteen representative paint manufacturers, were the ones tested. Neither the exact composition nor the trade-names of the paints have been published, but two in-

dependent sets of chemical analyses were made by competent members of the A. S. T. M. in the endeavor to establish the composition of each paint, and these analyses were published. It cannot be said, however, that these analyses satisfactorily established the composition in many cases, and they are in many particulars not intelligible to engineers. It is hoped that the A. S. T. M. Committee will find a way to supply full information as to commercial names and proportions of the ingredients of these paints.

"The paints were applied to consecutive panels of the bridge members, one kind to each panel and to nine steel plates, 24 by 36 in. surface dimensions, the plates behind placed in vertical position along the lower chord of the bridge. The paints were all applied under the supervision of a director of tests appointed by and under the direction of the A. S. T. M. Committee. Three coats were applied in all cases, with one exception, but a notable feature of the plate test was that the spreading was at the measured rate of 1,200, 900 and 6C0 sq. ft. per gallon respectively for three plates in each set. The rate of spreading on the bridge members was not measured, but it was reported as generally less than the smallest rate on the plates. The test-plates were cleaned by pickling. The bridge members were thoroughly cleaned by ordinary methods. (The shop coat appears to have been linseed oil, some of which was removed before field painting, but much of which was painted over.) No painting of bridge members was done except when the weather conditions were suitable. The exposure was to pure atmospheric conditions only, except that the bridge members received the drippings from passing trains.

"The bridge members and test plates were painted and exposure commenced in the fall of 1906 and annual examinations were subsequently made and reported by the Committee. For over six years all these paint coatings, with one exception, remained in generally excellent condition, almost fully protecting the metal of both the bridge and test-plates. Following the spring inspection of 1913, the Committee concluded that seven paints were no longer in condition to afford proper protection to the bridge members. After the next examination, in the spring of 1914, the Committee was of the opinion that all the bridge sections needed repainting because of the condition of the coatings on the horizontal surfaces, although a large part of the surface was still in excellent condition. We are informed that while the experimental paint included the bridge floor system, the inspections and reports of the Committee refer only to portions of the bridge other than the floor system. It is notable that the Committee reported the coatings on the vertical bridge surfaces in generally better condition than those on the plates, due probably to the heavier coatings on the bridge and some help from the shop coat.

"The plate coatings were all rated, on a comparative scale, as to their condition, at each examination, but on account of the lack of information as to the composition of the paints, there is not much to learn as to the effect of composition. However, the analyses give unmistakable evidence of the composition of some of the paints, especially the pigments. This is particularly the case of the red lead pigments and it may be noted that the paints with red lead pigments received the highest marks at the end of the test. The highest mark for any paint at the 1914 examination was given to the set of coatings, the pigments of which are shown by the analysis as straight red lead for all three coats and this mark held good for all three spreading rates, between which there was little to choose. The second-best mark was a tie between another case of three coats of paint with straight red lead pigment and one with a first coat with mixed white lead, zinc oxide and other pigments and two over-coats with a pigment of carbon or lampblack, mixed with red lead. The third-best mark went to a case of 70 per cent red lead primer with a first over-coat for which one analysis shows 56 per cent red lead in pigment and a second over-coat the pigment of which appears to have

been mostly carbon or lampblack. In general, it would appear that this test has been of value in demonstrating (1) that six or eight years' protection may be obtained from commercial paints when properly applied in three field coats to carefully cleaned bridge surfaces (possibly excepting floor system) and subjected to ordinary weather and train service conditions: (2) that (with a few exceptions) the serviceability of the coatings increased with their thickness; (3) that test plate results give a valuable indication of service conditions; (4) some information as to the comparative efficiency of different paint materials.

"Reports of other valuable tests and papers on the subject in hand which have come to the notice of your Committee during the year are the following:

Paper on "Painting Structural Steel: The Present Situation," by A. H. Sabin, with discussion by eight persons; Trans. A. S. C. E. 1914 p. 952.

Paper on "The Protection of Iron and Steel by Paint Films," by Norman A. Dubois, Journal Industrial and Eng. Chemistry, Vol. 5, No. 12, December, 1913. The author of this paper points out that by all prominent theories of corrosion, penetration of the paint film by gases and moisture is necessary for corrosion of the underlying metal, and concludes that imperviousness of the film, without impairment of durability, is the important factor in protection of metal. He considers special treatment of the vehicle as well as selection of pigments necessary to accomplish this, and shows by certain test results a superiority of paints having a mixture of kauri gum varnish, in small proportions, with the linseed oil of the vehicle, over paints with straight linseed oil vehicles.

"The year has been notable for the increase in the use of commercially prepared red lead ground in linseed oil, which has been made possible only through the production of red lead entirely free from litharge."

In commenting on the results of the Havre de Grace Bridge tests the Engineering News on May 25, 1916, said:—

"RED LEAD FINISHING COATS.

"Since the Havre de Grace bridge test showed three-coat red-lead work in first and second place for endurance there has been some attention given by bridge engineers to the use of red lead for finishing coats. The most interesting recent case of red-lead top coats is the heavy plate-girder crossing of the Nickel Plate over the Illinois Central R. R. at 79th St., Chicago, whose design and construction were described in Engineering News recently. The structure was painted with three coats of red lead, the second and third coats being tinted with lampblack to different shades. The third or final coat was mixed with 6 lb. of lampblack per 100 lbs. of red lead, giving a very dark brown color. The total rate of paint consumption on this structure was 1 gal. per 20 tons of steel, but in considering this it must be mentioned that the floor steel is incased in concrete and thus does not expose any painting surface; if the figures are corrected by taking account of the tonnage not painted, the steel covered is about 11 tons per gallon, according to George H. Tinker, Bridge Engineer.

"The lower 5 ft. of the Sewell's point coal pier, Virginian Ry., was painted three coats of red lead—the top coat black and the second coat brown, obtained by different admixtures of lampblack. F. F. Harrington, Engineer of Structures of the Railway, says that the following paint mixtures were used, after cleaning the steelwork and removing the rust with scrapers and iron brushes:

	First coat	Second coat	Third coat
Paste red lead, lb.	100	100	100
Lampblack-in-oil, lb.		6	52
Chinese blue-in-oil, lb	.		16
Linseed oil, gal.	2.9	3.64	15.20
Paint, gal.	5.02	6.42	24.55

"For general use the National Lead Co., which is largely interested in paste red lead, recommends lampblack additions ranging from a few ounces to about 6 lbs. per 100 lbs. red-lead. For a light brown, 12. oz. of paste lampblack is added; 4 to 5 lbs. will give a dark brown, and 6 lbs. a very dark color. These browns lack all the glaring orange quality of the natural red-lead color. Handsome green colors are obtained by the use of chrome yellow and Prussian blue; 31 lbs. of chrome yellow and 13 lbs. of Prussian blue per 100 lb. of red lead give a rich dark green. As this addition is accompanied by a considerable increase of oil, the expensive colors do not add to the cost of the paint as much as might appear. At normal peace-time prices the last-mentioned paint costs about 25 cents per gal. more than red-lead paint, according to F. M. Hartley, of the National Lead Co."

The 1915 report of the committee of the American Railway Engineering Association also contained a study of painting methods at bridge shops and in the field.

"Inquiries were sent out to steel bridge and structural fabricating companies well distributed geographically for information as to their practice.

"A special observation of the painting methods at two of the largest bridge shops was made. It is the intention to make a considerable number of such observations. The reports on the observations made are interesting and as follows:—

"Shop A—From what I saw at this plant considerable pains are taken to properly clean surfaces before paint is applied. The procedure in three separate instances was alike. The surfaces were cleaned by the use of benzine, applied with a flat brush to the most of the inside surfaces of two end-posts, webs and top-gusset plates. These posts were about 35 to 40 feet long and perhaps 30 in. square, with double lines of rivets in each web leg of angles, and webs reinforced for part of their length. After the benzine had been applied, the surfaces were wiped with clean waste, then scraped until loose material fell off; then brushed with a fiber brush. Paint was then applied,—red lead and oil, in two instances. It was well rubbed out and was what I would call very well done. The posts were then turned, one turn, so that webs were horizontal, cover plates and lattice bars were vertical. The same methods of cleaning the covering plates were pursued. The lattice bars and tie plates were scraped, care being used as in case of webs in cleaning and applying paint. Four men, all Greeks, were at work on these members, and they were probably doing as they had been accustomed. I took them to be average men and found out that all had been engaged in the work of painting for at least one year and that none of them did any other kind of work. Of these four men, one was paid 22, two 21, and the other 24 cents per hour.

"They did not stir the paint in the pails. They obtained their supply of paint from a barrel or tank in which a rotary paddle, driven by a worn-out air reamer, was constantly in motion. The paint was of the consistency of 25 lbs. of red lead per gallon. The paint pails held about one gallon. The paint was applied with 4-in. flat brushes. I would consider this work well done as to cleaning and paint,—perhaps 95 per cent of the ideal.

"The third instance was in the painting of a small girder, about 48 in. deep and perhaps 30 to 35 ft. long. This was painted by two men, one on each side, cleaning, scraping and brushing the same as in the other instances; same means, same tools, not the same men who painted the

end-posts. The paint applied was a carbon paint. If anything, the work of painting was slightly better than the red lead.

"The day was fine, slight breeze, sunlight, painting outside. The painters did not know me. I made no sign, nor spoke a word and am sure no one had been advised of the purpose of my visit.

"Shop B—They do not take as much care with cleaning as at Shop A, no benzine being used. Surfaces are wiped with cotton waste if dirty and the scraping is the same, except they use a whisk-broom after the scraper. One man was putting on red lead and oil, and as far as I could see it was as well applied as at Shop A, and by a man who, I was told, had been engaged in painting for about four years and who did nothing else (also a Greek, by the way). This painting was done under cover and in a place fairly free from floating dust. A number of finished members of varied kinds painted with several kinds of paints, were stored near where the painting was going on. I would say it all looked well. This shop has over an acre under cover.

"From this covered area I went to the loading yard. Here were a number of girders, all alike, for the (mentioning a large public works construction), length about 40 ft., 48 in. deep—no cover plates. It was new steel, neither angles nor web plates showing any evidence whatever of rust. The steel did not look as if it had been away from the mill more than ten days or two weeks. The work had been done on the girders in the shop and they had come out into the yard remarkably clean. The painters (two of them) were scraping off the assembling paint that had run down the web when it got hot from driving the rivets, and any loose dirt that might have adhered to it; also wiping surfaces, where needed, with cotton waste. The paint applied was (proprietary name) I think. At any rate, it was well applied and looked well soon as it went on. It was subject to the ash and smoke deposits from a blast furnace a short distance away, the stacks belching out clouds of a fine dust which settled down on the girders. So much of this dust had settled on the tops of some girders painted two days previously and before the paint was dry, as to remind one of sandpaper when the fingers were rubbed over the surface. The color was likewise changed to a brownish-gray instead of black.

"The work of painting at Shop A and also at Shop B is let out by contract to a contractor who hires his own men and pays them; he furnishing the labor for application and the contractor for the steel work furnishing the paint materials."

"COLLECTION OF INFORMATION AS TO THE PRACTICE OF IMPORTANT RAILROADS OF THE UNITED STATES AND CANADA IN REGARD TO THE KINDS OF PAINT USED AND THE METHODS OF APPLICATION.

"A circular letter was sent out to an official of each of the principal railroads (with a few exceptions), in the United States and Canada, the officials selected being members of the Association. The same letter was sent to a member official of each of several foreign railroads. The circular made inquiry by means of several questions grouped under the headings of (1) shop coat on new fabricated steel; (2) field coats on new fabricated steel; (3) repainting or maintenance of bridges under traffic. These circulars were sent to 67 different railroads or railroad systems and replies were received from 53. The questions and the substance of the replies relating to the repainting or maintenance of bridges under traffic are tabulated in Table 4. The following is a summary showing the extent of use of each kind of paint as indicated by the replies; figures and percentage referring to individual railroads:

1. Kind of shop paint used:
   Red Lead pigment, 29 out of 50, equal to 58 per cent.
   Linseed oil only, 5 out of 50, equal to 10 per cent.
   Linseed oil, parts in contact after assembling with red lead pigment paint, 2 out of 50, equal to 4 per cent.
   Linseed oil, parts in contact after assembling with various proprietary paints, 4 out of 50, 8 per cent.
   Graphite and carbon pigment paints, including lampblack paint, 8 out of 50, 16 per cent.
   Miscellaneous, 2 out of 50, 4 per cent.

2. Kind of paint (classified as to pigment) used for field coats new steel.
   Red Lead straight or in part, 12 out of 48, 25 per cent.
   Carbon or graphite or both, 24 out of 48, 50 per cent.
   Miscellaneous, 12 out of 48, 25 per cent.

3. Kind of paint (classified as to pigment) used in maintenance:
   Carbon, 13 out of 46, 28 per cent.
   Graphite, 7 out of 46, 15 per cent.
   Both carbon and graphite, 4 out of 46, 9 per cent.
   Red Lead straight or in part, 11 out of 46, 24 per cent.
   Various, 11 out of 46, 24 per cent.

The above figures do not include the New Zealand Railways.

The general features of the subject of painting structural steel were so well set forth in a committee report on this subject before the American Railway Bridge and Building Association in 1912 that the report, which is concise and complete is set forth here in full:—

"As a number of separate and distinct operations are necessary in the proper performance of a job of structural steel painting it appears best that the subject be divided and the different stages separately presented. Also, in this discussion, the process of coating new steel, and the work of repainting old structures should not be confused.

"Scientific research and numerous practical tests have demonstrated the fact that certain paint pigments, though possessing excellent moisture repelling properties, will actually stimulate corrosion when applied directly to steel surfaces, while certain other pigments have a tendency to restrict and repress corrosion when used for primers and foundation coats. Because of this, we divide the pigments into rust retarding, and air and moisture excluding ones, using the first for priming and contact coats, and the latter, for finishing and exposed outer surfaces. The pigments used in steel protective paints of the first kind are principally, red lead, oxides and the like, while carbons, lampblacks, graphite, etc., belong in the other class.

"Shop Coating.—A Rust retarding coat may be suitably compounded from red lead mixed with pure linseed oil. The average stock mixture may consist of from 25 to 30 lbs. of red lead to the gallon of oil. This mixture can then be reduced to the proper consistency at the time of application. A small amount of turpentine added to this brush coating will greatly help in its manipulation and will also provide for proper penetration. Red lead should always be mixed at the time of its application, for it settles quite readily, as it is an extremely heavy pigment. If so desired, the settling can be retarded, to a certain degree, by the addition of a small amount of asbestine (magnesium silicate) in the proportion of about 20 lbs. of red lead and 2½ to 3 lbs. of asbestine pulp to the gallon of linseed oil. A small amount of turpentine should also be added to this mixture for the purpose mentioned above. A good workman is required to properly apply red lead paint because of its more or less difficult application.

"Natural oxides have also grown to be very good for priming purposes, and very satisfactory results are recorded from their use. A number of consumers favor oxides because of their easier application and the

less expert class of labor which is required to apply them. A saving of from five to ten per cent, as compared with red lead paint, can thus be effected. Some concerns are using a combination of red lead and oxide and make good reports regarding it. A number of reliable paint firms have similarly composed products on the market, which are sold under certain trade names, and some concerns have adopted them as their standards.

"Although quite extensively used in former years, linseed oil is rapidly losing favor. It appears to be a universal opinion that linseed oil is not a desirable material for the prime coating of metals when used without the addition of pigments. A foundation coat of linseed oil is very often the direct cause of peeling and blistering of the other several coatings applied over it. The oil is seldom dried enough to insure close adherence to the metal surface which it covers before the other paints are spread over it. When the subsequent coats of paint are spread, the solvents and oils in them are bound to soften to some extent the underlying coat of oil, and the moderate heat of the sun alone is sufficient to cause the whole film to draw up, blister, and finally peel. Too much oil in a paint coating, particularly when the surplus is in or near the foundation coat, will generally cause blistering and peeling, regardless of the pigments used in the coatings. If, on the other hand, the erection or final completion of an oil-coated structure should for some reason become delayed, this oil film, which deteriorates much faster than a paint coating, will have practically perished; its surface will be morbid and dead and will not have strength and stability enough to carry any subsequent coats, which when applied over this kind of a surface, will also peel.

"Field Coatings.—Paints containing the same kinds of pigments as for shop coatings, can be successfully used for the first field coat, providing it is covered with another elastic outer coating. If that is not done, paints suitable for finishing coats should be applied, and the first field coat omitted. Red lead or oxide priming should be darkened for this coat by adding carbon or lampblack in the proportion of 90 to 95 per cent of the reds and 5 to 10 per cent of carbon mixed. The addition of this black will not only help to make the coating more elastic, but will act as a guide to determine if the former surface is being completely covered because of its darker shade and the shade is also brought nearer to the color of the black finish coating.

"Carbon, lampblack and graphite pigments, singly or mixtures of them, have given best satisfaction as outer surface and finishing paints. These combined with some inert and reinforcing pigments, according to special formulas form the basis for nearly every brand of paint for the satisfactory metal coatings on the market. The addition of some high grade gum like 'Kauri' improves a finishing paint greatly, producing more elasticity, resistance and life. It is, of course, just as essential that the oils entering into the makeup and composition of the various paints are of the proper kind and quality, as that the selection and composition of pigments be properly made and storekeepers or other officers charged with the duties of passing on the merits of goods purchased should be very alert and strict in regard to linseed oil. Paints containing tar, or those with a tar base, should not be used on steel structures exposed to the sun and weather, as tar-paint films rapidly check, crack and 'alligator.'

"Repainting.—When for any reason it becomes necessary to repaint an iron or steel structure, the paint should never be applied in wet or freezing weather, and the surface should be freed absolutely from all scale, rust, dirt, etc. It is not sufficient to merely apply a fresh coat of paint over an old paint surface under which traces of paint corrosion appear, for while the new paint will cover up the old surface, and may adhere firmly to it, corrosion goes on beneath the paint just the same. Freeing from rust and corrosion and perfect cleaning are positively necessary. When for some reason it is not possible that the entire structure can receive a coat of some rust-retarding primer, the parts cleaned and freed from rust, and all the exposed surfaces, at least should be touched

up with either a red lead or oxide primer, before the finishing coat is given. The use of turpentine in the paint applied over the old surface is advised, as turpentine is a penetrant providing the penetration and adhesion between the old paint film and the new coat.

"Although more expensive, cleaning by sand blast is much more thorough than the hammer, chisel, scraper and wire brush method, and the greater cost is readily offset by better results in the end. The sand blast method thus far has not been very extensively used, so the committee has not been able to gather full data as to the cost, etc., but we believe that the matter is worthy of deliberate consideration. Where the sand blast has been used, the steel so cleaned and the steel has been painted promptly, it has not shown signs of corrosion again nearly as quickly as steel cleaned by hand.

"Occasionally we notice defects showing up here and there on a steel structure within an unusually short time after the completion of the painting. On looking into the matter we find that nothing extraordinary has occurred during the progress of the work. Everything has been handled in the usual way, the general course of mechanical procedure has been followed, and still improper results are appearing. We recall no acts of our own to which to lay the blame and are finally compelled to look for the cause previous to our own handling of the work, or to the priming, which was done at the works or in the mill. We are not certain beyond a doubt, so we decide to visit a mill, and there make personal observations, which may very probably result as follows: In one part of this enormous plant we find the inspector busy in the pursuit of his duties, checking, comparing specifications, testing, weighing, and attending to the many details connected with his work. In the meantime, we notice in another remote part of the place a bunch of unskilled laborers mopping paint onto some steel that had been sent along for priming, using large 6 in. or 8 in. flat brushes, and covering over mill scale, rust, dirt and other imperfections, each and every one a destructive agent and an enemy to the life of steel. We observe all these stimulators of corrosion brushed over and covered up with paint, but not removed, and so the march of the corroding process is sure to go on. We next pay attention to the paint they are using and learn that the package, which was opened some time ago to be inspected and was left standing uncovered all this time, had contained the standard paint as specified, but now, through neglect to properly cover, is no longer fit for the purpose used. On examining the contents of the package closely, we also notice that the paint is scarcely stirred up, and we see that the oily substance from the top of the mixture is first used, and as the work progresses and the material is consumed, the paint becomes heavier and intermixed with more or less pigment, until when the lower part of the package is reached nothing is left but a semi-dry pigment, which will no longer spread under the brush. Now, to assist in brushing, the men reach for the benzine can and reduce the paint with it, destroying what little life the paint had first contained. In this way a number of different surfaces and films are created on the same structure, and from the same package of the so-called protective coating.

"We proceed further, and find at other parts of the mill, though this time under a cover shed, more laborers applying a shop coat to other sections and parts of the structural steel. Here we notice exhaust pipes of all kinds steadily discharging vapor and moisture which finally settles and deposits on the steel. Under such conditions the steel cannot be perfectly dry, however much it may appear so, yet the painting is done just the same; these layers of moisture are enclosed between the surface and the steel, and the paint, which is supposed to close the pores and firmly adhere to the steel, is merely attached in some places and spots, and a weak foundation is created which is absolutely unfit to receive and successfully hold subsequent coats of paint.

"While we have gathered all this valuable information the inspector has found an opportunity to inspect the painting on these various sections of the steel. He looks at the job, and as it looks uniform in color,

he regards it as properly done, because it is outwardly covered over with paint. The material is consequently passed, loaded and shipped.

"The foregoing illustration may appear somewhat severely drawn, and the situation presented greatly exaggerated; nevertheless, if a number of troublesome cases were thoroughly sifted, the illustration, in part, or in whole, would be identical with the underlying cause of the trouble.

"It must not be construed that our illustration is intended to cast any reflections upon the inspector or his methods. On the contrary, it is sought to imply that he uses his principal efforts in a direction considered primarily important, which is the correct fabrication of the parts composing the structure. No matter how diligent and untiring an inspector may be, it is not possible for him to be in a number of places at the same time, for, in large plants where modern methods are pursued in the manufacture and assembling of steel, the various departments are sometimes miles apart.

"Of course, not all failures are due to work which was first painted at plants, for often, even among so-called intelligent mechanics, the belief still exists that anything in the way of paint is good enough for priming purposes, so long as it is going to be covered again with paint, thus entirely ignoring the fundamental principles of a correct foundation.

"It may, therefore, be suggested that considerable attention be given to the education of men who deal in, or supervise the erection and maintenance of steel structures, so that greater interest in the problem will be aroused, better coöperation between the various departments effected, and the proper men chosen to handle the different lines of work."

The 1916 report of the Committee of the American Railway Engineering Association contains reference to a new method of coating with easily fusible metals as follows:—

"During the year a new method for coating with metals has been called to the sub-committee's attention. This is the so-called Schoop Metal Spraying process, by which surfaces may be coated with easily fusible metals such as lead, tin, zinc, aluminum, copper, brass, etc. The process involves an apparatus called a 'pistol' which is a mechanism somewhat resembling a large pistol and which feeds wire, of the metal to be deposited, into a blast flame of combined oxygen, reducing gas and compressed air, which results in the issuance from the nozzle of the pistol of a spray of fused metal. This spray, when directed upon a proper surface, coats the latter with the metal. Iron and steel surfaces are readily coated after cleaning by the sand blast method. It is claimed that a coating of zinc or lead can be applied at a cost of only a few cents per square foot of surface, including the preliminary sand-blasting."

Perhaps the most interesting development in the protection of steel in recent years is the practice of coating the steel with a thin sheet of cement grout applied as a plaster or by means of a cement gun, and while the coating is not strictly speaking, a paint, it should, properly speaking, be considered with the paints. Several roads have already done considerable work along these lines, and their experiences are so well related in the 1914 report of the Committee on Iron and Steel Structures of the American Railway Engineering Association, that the information is reprinted here:

"BLAST BOARD.

"The two roads reporting agree that concrete encasement, when subjected to the blast action of locomotive exhaust, must be protected by some kind of a blast board and recommend the use of steel plate, cast-iron (exposed surface chilled) and vitrified and glazed tile. To date the use of the steel or iron blast board has proven effective.

"The Kansas City Terminal Railway Co. is conducting experiments with the use of transite board and means of fastening to the structure.

"ENCASEMENT WITH CONCRETE.

"The four roads reporting recommend the use of concrete for the protection of steel of highway bridges, passing over railway tracks, and the protection of the concrete from blast action as given above.

"CONCRETE ENCASEMENT.

"Concrete encasement as a protective agent for that portion of steel structures exposed to the blast and gases of locomotives has come into use due to the trouble experienced with paint and to the cost of maintenance of the same.

"That concrete properly applied is an ideal protection will, we believe, be conceded by everyone interested, even though they do not generally use it.

"The use of the concrete encasement is in a way limited by railroads to undercrossings and to city bridges where the headroom is close and the railroad traffic heavy.

"Painting.—In the above locations protecting floors by the use of paint is at best unsatisfactory and the cost while varying with the conditions will be somewhere in the neighborhood of $1.25 per ton per year. A fair average relation of weight to area is .065 square ft. per lb. of metal, this giving, using the above value, a cost of 0.96 cents per square ft., per year, for painting.

"Poured Encasement.—If the floor is protected by the use of concrete encasement poured in place, the cost per square ft. will be as shown later approximately 25 cents per square ft., the encasement being three in. in thickness.

"Gun Encasement.—Encasement of the floor by use of the cement gun, the encasement being three in. in thickness, will be shown later approximately 23 cents per square ft.

"The Committee has written to the several roads regarding their experience with encasement and the following extracts from the replies have been received:—

"W. F. Jordan, Manager Grand Central Terminal Improvements, New York Central & Hudson River Railroad.

"The cement is being used at the Grand Central Terminal for fireproofing and protecting a part of the steel structure of the Grand Central Terminal Improvements. The yard is in two stories, the upper tracks being supported on a steel structure with concrete jack-arches. It was necessary to get the upper tracks in service at an early date, so the fireproofing of the exposed parts of the steel below the jack-arches was not done at the time the floor was built.

"The lower parts of the beams, the girders and columns are now being fireproofed with the cement gun, using a minimum thickness of 2 in., the average thickness is from 2-½ to 3 in., as in the angles and around the stiffeners there is generally more than the minimum thickness.

"The fireproofing is reinforced with a wire mesh, 1-½ x 1-½ in. of No. 12 wires: this is attached to ¼ in. rods, which are bent around the steel and fastened to it.

"The mixture has generally been 1 to 3, but in cool weather, and where the steel is subject to vibrations from the trains running on it, a 1 to 2 mixture is found to be more economical, as it is not as likely to drop off. It is necessary with this machine to use fine sand, as sand with pebbles in it clogs the hose; all of the sand, therefore, has to be carefully screened.

"We find that a cubic foot of 1 to 3 mixture, when weighed in a box of 1 cubic ft. capacity after being moderately shaken down, weighs 93 lbs; if this mixture is wet and applied with a trowel, after setting it will weigh 127 lbs. to the cubic ft.; when shot through a cement gun onto a steel structure and set up, it weighs 144 lbs. per cubic ft. From this you

will get an idea of the density of the fireproofing made with this apparatus.

"In applying the mixture of sand and cement with the cement gun from 20 to 25 per cent of it is lost. Some bounces off as it strikes the structure, some is shot by the steel in working around the angles and to get a smooth surface the mason scrapes off the irregularities, and to get a good surface it is floated.

"The labor required to operate one machine is as follows:

1 Foreman,
1 Operator of the machine,
1 Nozzleman,
2 Masons for floating,
4 Laborers screening, mixing and charging the machines.
Carpenters are used when necessary to erect scaffolds.

"One of these machines uses compressed air to the amount of 100 ft. of free air per minute at a pressure from 35 to 40 lbs.

"The hose through which the mixture is conveyed wears out quite rapidly and renewals amount to about $1.00 per day.

"We have averaged covering about 500 square ft. per day of the thickness mentioned above.

"This method would appear to give an excellent protection for the steel. The material is very dense and the method of application such that every inch of the structure is uniformly protected. The great thickness used in this work is due to the municipal laws requiring at least 2 in. of fire protection."

"J. J. Yates, Bridge Engineer, Central Railroad of New Jersey.

"It is our practice, wherever practicable, to protect the steel of highway bridges or structures over our tracks by encasing in concrete. Where in close proximity and subjected to the blast of the exhaust from the stacks of locomotives, this has not proven altogether satisfactory.

"A concrete floor was installed in our bridge over the Pennsylvania Railroad at Newark, N. J., at which point there is only a clearance of about 12 in. above the stack. Within six months' time the concrete over the exhaust had been blown off to a depth of about 2 in. and it is now contemplated to use a seven-sixteenths in. steel plate to protect the concrete. This type of steel plate protection was installed about two years ago by the Pennsylvania Railroad when they renewed their bridge over our tracks at Elizabeth, N. J., the previous bridge being so badly disintegrated by gases as to require renewal. Up to the present time this has proven very satisfactory and looks as if it were still good for two or three years. The original bridge was built about 1892.

"We have experimented with paints in the protection of steel work from exhaust but as yet have found nothing of any value. Our practice at the present time is to protect such portions as it is possible by encasing in concrete or by cast-iron, steel plates or wood, the cast-iron or steel plates being used when the structure is close to the exhaust of the locomotive.

"At our Newark bridge above referred to, before putting in the concrete we had a wood protection of hard pine which it was necessary to renew about once in three months, and, on the whole, offered a very poor protection, as pieces of wood were being constantly blown off, exposing the steel work."

"W. F. Steffens, Engineer of Structures, Boston & Albany Railroad, Reporting to the New York Central Lines Bridge Committee, June 20, 1912:

"We have just completed at Tremont Street, Boston, a bridge over four tracks of the Boston & Albany Railroad. The minimum clearance from top of rail to under side of bridge is 15 ft. 1-¾ in. It is evident,

therefore, that the top of stack of the highest locomotive passes the bridge by but a few inches clearance. The old structure was of the usual open-floor type, with pony trusses, was built in 1889 and when removed was practically deteriorated to not less than 50 per cent of the original sections, where exposed to gases.

"The new structure is of plate girders, with a floor of total depth of about 2 ft. 1 in. consisting of 15 in. beams spaced 1 ft. 6 in. center to center and incased entirely in concrete to form a solid slab, upon which the rails of the Street Railway Company and the paving are laid. The concrete is supported under the flanges of the beams by means of a net work of ¼ in. rods attached to the beams by means of thin hangers of strap steel 1/16 in. to ½ in. in section hooked over the top flanges.

"It was very evident that under the severe conditions existing at this structure, the concrete protection would soon be worn away by blast action. To prevent this, we embedded in the concrete over the center line of each track a series of cast-iron blast guards 1 in. thick by 20 in. wide and in convenient lengths, attaching these to the concrete by means of hook anchors into the slab. The exposed surface of the cast-iron was chilled in order to harden it.

"To date this blast guard construction has demonstrated that it will be effective indefinitely in protecting the concrete undersurface. The blast strikes the plate and is deflected horizontally as intended.

"At the large bridge at Worcester, Mass., for the section over the New York, New Haven & Hartford Railroad, we have been limited by the court to the minimum 18 ft. 0 in. prescribed by the Railroad Commissioners. For the protection of the surface exposed to direct blast action at this greater distance above the tops of stacks, we intend to specify a special vitrified and glazed tile."

"O. E. Selby, Engineer of Bridges and Structures, The Cleveland, Cincinnati, Chicago & St. Louis Railway:

"We have used concrete protection on some structures over railroad tracks with entire success. It is necessary to apply the concrete to a mesh of expanded metal or wire, and secure this mesh to the steel work at frequent intervals, also to protect the underside of the concrete casing from abrasion from the locomotive exhaust. For this latter purpose, we have used a protection plate one-half inch thick applied to the underside of floor beams, girders, etc., and made a part of the bottom flange, although it is not included in the computed flange sections. This protection plate extends 2 in. beyond the other flange plates and forms a shelf for the support of the concrete casings above. The oldest structure with this protection plate is about five years and is in perfect condition as regards that detail."

"G. E. Tebbetts, Bridge Engineer, Kansas City Terminal Railway:

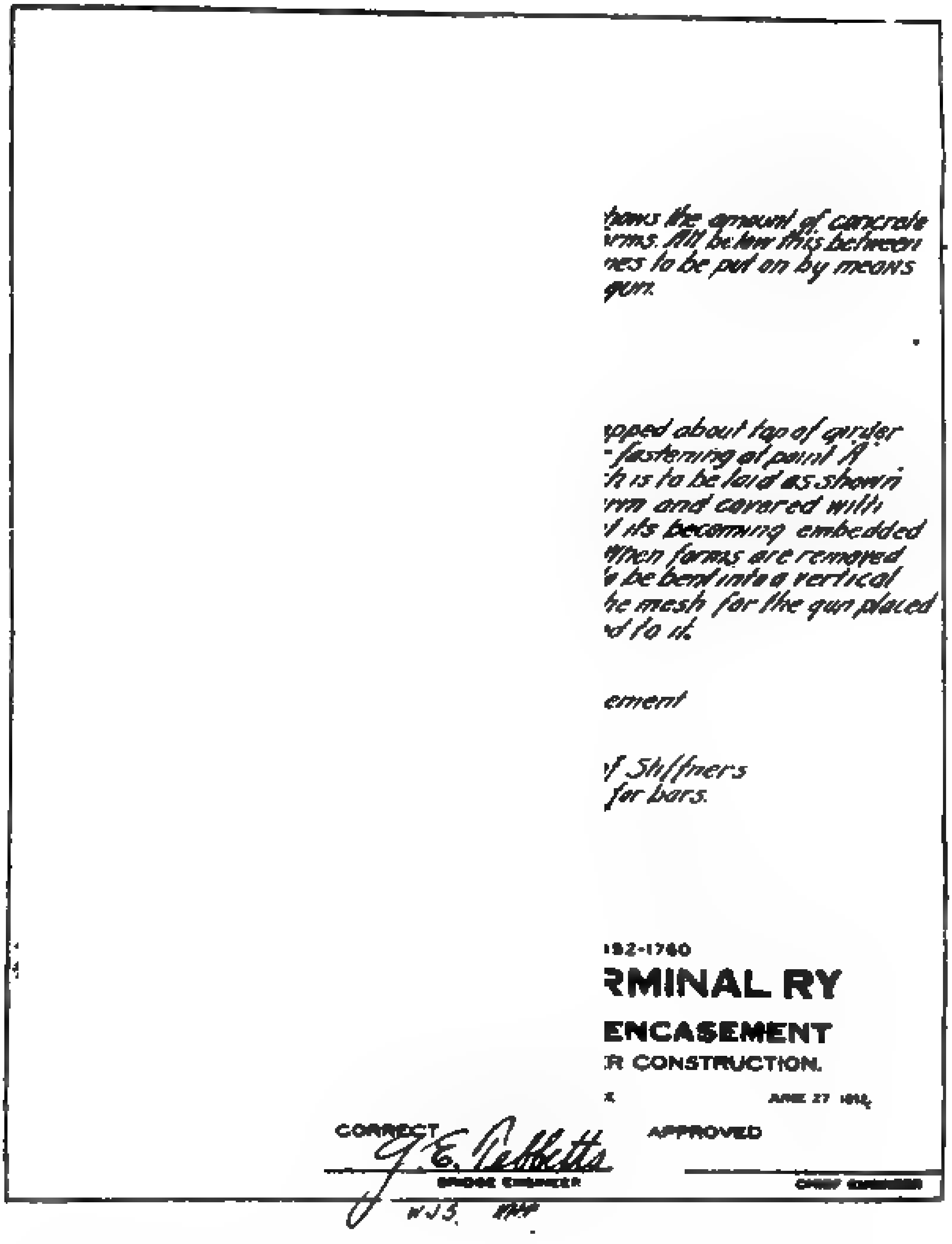
"When the Kansas City Terminal Railway Company took over the Kansas City Belt Railway to be used as their main line, there were among other structures four overhead highway viaducts which were of the encased type, i. e., having the floor system protected by concrete. A brief description and the results of a recent inspection may be of value.

"One of the bridges was erected in 1903 and the other three in 1906.

"The one erected in 1903 was of a through-girder type, 64 ft. long with suspended floor beams, the bottom flanges of the stringers flush with the bottom flanges of the girders.

"The plans called for 1½ in. of encasement held in place by No. 10 gage, 3 in. mesh, expanded metal and ½ in. bolts, mortar to be 1: 2: 4 mixture. The roadway floor and sidewalk to be 1: 2: 4 concrete 5 in. thick reinforced with expanded metal. All steel encased unpainted.

"The bridge was constructed as described, except that the encasement varied from 1½ in. to 3 in. in thickness, in general being 2 in. The concrete was put in dry and tamped and the mortar for the encasement was also made stiff, being rammed into the forms. The bottom board



was held in place by bolts, and after the forms had been filled the bolts were tightened to force the mortar onto the steelwork. No waterproofing was used. Overhead clearance was 19 ft. 0 in.

"Recent inspection showed the encasement on underside of floor-beams, stringers and girders over main track nearly all gone. The encasement over industry tracks was in a little better condition but concrete was missing in quite a few places, notably lower flanges. The lower surface of floor was wet. Samples of concrete were taken and tested for excess of sulphur, but no excess was found.

"It was concluded that most of the trouble was due to the seeping of water through the cracks in the concrete floor and also between the encasement and the steel, this act on loosening and cracking the concrete and rusting the reinforcement, finally causing the concrete to drop off.

"On the three structures erected in 1905 the encasement work was in about the same condition as the one above described, the cause seeming to be the same, i. e., the seeping of water down between the steel and the concrete.

"On the new structures the Kansas City Terminal Railway Co. is building, the encasement is applied in the majority of cases by use of the cement gun.

"Cement Gun.—This machine consists essentially of a hopper into which the cementitious materials, made up of one part Portland Cement to three parts dry screened sand, are placed; a hose connected to the bottom of the hopper, through which the mixture is forced by air pressure; a nozzle at the end of the hose, to which another hose supplying water is attached for hydrating the materials.

"At the end of the hose is a cylindrical nozzle having an annular ring at its base, to which the hose delivering the water is attached. This water is delivered inside the nozzle in the form of a fine spray, through which the materials from the gun pass. The nozzle is made of brass, and to prevent wear on the nozzle proper a rubber lining is used. This lining can be replaced whenever necessary.

"Before adopting the cement gun, the claims of the company selling it were investigated and test panels were encased. The conclusion reached was that if the cost was not too great, it would solve the problem of encasement.

"Comparative estimates made are shown below:

Encasement by pouring in forms. Encasement to be 3 in. in thickness. Mixture to be 1: 2: 4 concrete. Reinforcement, wire mesh and bars.

Stone, 1 cu. yd. at $1.25	$1.25
Unloading 1 cu. yd. at 20 cents	.20
Loss in handling, at 5 per cent	.07
Sand, ½ cu. yd. at 60 cents	.30
Unloading ½ cu. yd. at 6 cents	.03
Loss in handling, at 5 per cent.	.02
Cement, 1¾ bbls. at $1.25	2.19
Unloading 1¾ bbls. at 5 cents	.09
Loss in sacks, at 5 per cent.	.03
	$4.18

One cubic yard equal to 108 sq. ft., 3 in. thick.

Cost of material per sq. ft.	$0.039
Forms $1.63 BM. at .050	.081
Mixing and placing at $5.40 per cu. yd.	.050
Insurance on payroll at 5 per cent.	.003
	.173
Overhead and profit at 8 per cent + 15 per cent = 23 per cent	.040

Cost per sq. ft. of encasement = .216

Encasement per sq. ft.	.216
Mesh No. 3 at $0.06	.018
Bars No. 5 at $0.03	.015
Total cost per sq. ft.	.249

Say 25 cents per sq. ft.

"Encasement by use of cement gun. Encasement to be three inches in thickness. Mixture 1: 3 mortar. Reinforcement, wire mesh and bars. Average number of square feet covered in a day of 10 hrs., 275 sq. ft. Loss due to gun work, 20 per cent. Loss due to handling sand, 30 per cent. Quantity of sand used in placing 275 sq. ft. three inches thick, 4 cu. yds.

Sand, 4 cu. yds., at $0.60		$2.40
Unloading and screening 4 yds. at $0.25		1.00
Cement, 5½ bbls. at $1.25		6.88
Unloading 5½ bbls. at $0.15		.83
Loss in sacks at 5 per cent.		.11
Water per day		.15
Gasoline for compressor, 12 gals. at $0.15½		1.86
Oil waste and handling per day		.60
		$13.83
1 Foreman, 10 hrs., at 37.5		3.75
1 Finisher, 10 hrs., at 35		3.50
1 Nozzleman, 10 hrs., at 32.5		3.25
1 Gunman, 10 hrs., at .30		3.00
2 Laborers, 10 hrs., at 22.5		4.50
1 Boy, 10 hrs., at .125		1.25
		$19.25
Repairs, etc., per day	2.00	
Scaffolding for 275 sq. ft. at $0.15	4.13	6.13
Interest on gun $3,000 at 5 per cent.	.41	
Insurance on payroll at 5 per cent.	.97	1.38
		$40.59
Overhead and profit 8 per cent and 25 per cent = 33 per cent.		13.53
Cost of encasement		$54.12
Cost per square foot		19.68
Mesh No. 3 per sq. ft. at $0.06		.018
Bars No. 5 per sq. ft. at $0.03		.015
		.2298

Say 23 cents per square ft.

"A comparison of the above shows a saving of 2 cents per square foot in favor of the gun work over the poured encasement, and it might be stated that since this estimate was made we have received bids on actual work that check very closely with the above.

"The steel work to be encased was designed with open holes 11-16 in. in diameter in webs, stiffeners and flanges, so that in placing and attaching the reinforcement there would be ample provision for rigid attachment to the structure. In attaching reinforcement to girder webs and other large surfaces, the bars were placed on small V-shaped iron saddles and wired through the webs to each other. On flanges the rods were run through steel eyebolts attached to the lower flange, the mesh being attached to the bars by wiring. At the junction of the concrete encasement with the floor, which is also concrete, a splice was provided by use of mesh placed in the floor previously cast, this splice being four inches in width.

"The steel girders were shipped from the shops with a shop coat of linseed oil, which was removed by the use of a caustic soda wash before encasement was started. All rust spots were removed with a wire brush.

"Our experience has shown that the 1: 3 mixture placed in the gun gives a resulting mortar of approximately 1: 2½, this change being due to loss of sand. The sand must be nearly dry, the dryer the better, a mixture of coarse and fine grains giving better results with considerably less loss, than either the coarse or fine alone.

"The sand must be screened as particles over 1/8 in. in diameter clog the gun and cause serious delays.

"The compressor should be a machine of very ample capacity and an intermediate air storage tank is an advantage.

"It was found that it was very difficult to encase the lower flange of a girder, especially so the lower face, and in our work we cast this portion in quite a few cases.

"It was also a difficult proposition to get a good, clean job around stiffeners and sidewalk bracket members. On the brackets V-shaped forms were made and used as a backing for the gun work. As to finish, the appearance is fairly good, though far from the smooth, even lines of cast work and a great deal depends upon the finish as to the final appearance.

"One great advantage of the cement gun work, especially so in a large terminal proposition, is that the viaduct can be put in service and the encasement work performed afterward when convenient without any material trouble.

"Care has been taken in all the work on this terminal to build and waterproof the bridge floors so as to prevent the seepage of water onto the concrete, or encasement work, and we believe that waterproofing is an essential in good encasement work.

"BLAST BOARDS AND SMOKE SHIELDS.

"At bridges and undercrossings where the headroom is close, the lower portions of the structure should be protected by smoke shields if floor is not encased in concrete or by blast boards over each track if steel is encased. As shown below in the replies received by the Committee, the concrete encasement is rapidly worn away by sand blast action if unprotected. A variety of materials are in use for this purpose, including timber, steel, vitrified tile and asbestos boarding.

"Below are extracts from replies to the inquiries sent out to the several roads:

"G. E. Tebbetts, Bridge Engineer, Kansas City Terminal Railway:

"Up to the present time we have not put into use blast boards on the work in hand, but the use of a 1/2 in. asbestos board 42 in. wide over the center line of each track is contemplated and will be put into service within the next few months.

"The old structures on the Kansas City Belt Ry. had, in quite a few cases, headroom varying from 17 to 20 feet and were built over the main line where the grade was 1 1/2 per cent., so that they were subject to very violent sand blast action from exhaust. On inspection it was found that the girder flanges and other portions of floor system over the uphill tracks were practically worn away by the action of the exhaust; the wooden floor joists being worn to a depth of about two inches by two feet in width over the center line of tracks.

"Several materials were considered for experimental purposes and it was finally decided to try asbestos board in two very severe locations. The boards were placed at a height of 18 feet above the rail at Grand Avenue and Troost Avenue temporary bridges. At the above points the grade of the tracks was 1 1/2 per cent. and the blast action very severe. The boards were left in service for about eleven months and were examined every month. It was found that there was practically no cutting action and the boards were finally removed when the temporary bridges were taken down.

"On the showing of the experiment asbestos blast boards have been adopted for use on the terminal work and will be installed in service in the near future.

"The committee submits the above for the information of the Association and believes that more time should be taken to go further into the use of this form of protection."

On June 30, 1916, Mr. G. E. Tebbetts, bridge engineer, Kansas City Terminal Railway advised the writer further as follows:—

"I have not obtained any more information, other than that covered in the report to the American Railway Engineering Association of last year. However, we have decided that we will reduce the thickness on the sides of girders from 3 in. to 1½ in., but will leave the encasement over the lower flange 3 in. as originally decided, as I believe this additional thickness is needed on account of sand blast action from the locomotives.

"I am just getting in shape to start a company force outfit on this season's work, and will be able to give you some interesting data as to actual cost some time late this fall. I have found out, however, it will be more economical to use a mesh with wires at right angles to each other, due to the fact that this can be cut into panel sizes and wired to the girders at less expense than the use of a woven wire, such as the American Steel and Wire triangular mesh, which will not lie flat."

Respectfully Submitted,

C. E. Smith.

IRON AND STEEL STRUCTURES.

TABLE 4.—QUESTIONS AND REPLIES RELATIVE TO REPAINTING OR MAINTENANCE OF BRIDGES UNDER TRAFFIC.

Railroad	Mileage	Name and Title	What kind of paint do you use?	What determining factors decide the repainting of your bridges?	Generally, how often are your bridges repainted, and whether wholly painted or in part?
			A	B	C
Atchison, Topeka & Santa Fe	5963	A. F. Robinson, Bridge Eng.	Proprietary paint	When weather exposure coating begins to wear thin and expose body coat	Every 4 to 8 years, depending upon condition
Atlantic Coast Line	4499	C. M. James, Asst. to Prest.	Red lead and linseed oil	When the life of the old paint is gone	About every 7 years; some parts oftener
Baltimore & Ohio	4456	W. S. Bouton, Br. Eng.	Carbon paint	As soon as paint wears off	About every 5 years; also patch painting is resorted to
Bangor & Aroostook	630	Moses Burpee, Chief Eng.	Graphite	Condition of previous painting	About 5 years; badly exposed parts oftener
Boston & Maine	2253	B. W. Guppy, Str. Eng.			
Buffalo, Rochester & Pittsburgh	586	E. F. Robinson, Chief Eng.	Carbon and graphite	Conditions	Every 4 or 5 years
Canadian Pacific	11641	P. B Motley, Br Eng.	Various	Age and state of paint	3 to 5 years
Central Railroad of New Jersey	676	J. J. Yates, Bridge Eng.	Silica graphite	Depends on localities	1, 2 and 4 years
Central Vermont	536	J. M. Morrison, Supt. and Eng.	Red lead and oil	Condition of steel	From 6 to 10 years, depending on location; floor system oftener
Chicago & Eastern Illinois	1282	L.C. Hartley, Chief Eng.	Proprietary paints; formerly carbon and iron oxide; now using carbon and linseed oil paints	Rusting	About every 5 years
Chicago & Northwestern	8090	W. H. Finley, Chief Eng.	Oxide of iron paints, also lamp black pigments	Conditions	5 years
Chicago Great Western	1496	C. G. Delo, Chief Eng.	Proprietary paint, carbon and iron oxide pigment.	Scale and rust	5 years
Chicago, Milwaukee & St. Paul	9612	C. F. Loweth, Chief Eng.	Paints of our own manufacture, and well-known proprietary paints	General deterioration decides repainting of bridges	Three to five years; some structures are carried by retouching
Cleveland, Cincinnati, Chicago & St. Louis	2629	O. E. Selby, Br. and Str. Eng.	Red lead and oil, also carbon or graphite paint	Condition of bridge is determining factor for repainting	On an average from four to twelve years
Delaware & Hudson	862	James M. MacMartin, Chief Eng.	Graphite	Conditions	5 years
Delaware, Lackawanna & Western	985	G. J. Ray, Chief Eng.	Comp. of red lead, graphite, lampblack and linseed oil	Conditions	3 to 4 years

Note: Table 4 (six pages) photographed from pages 630-635, Vol. 16, Proceedings American Railway Engineering Association.

IRON AND STEEL STRUCTURES.

TABLE 4.—QUESTIONS AND REPLIES RELATIVE TO REPAINTING OR MAINTENANCE OF BRIDGES UNDER TRAFFIC.

What methods do you employ in cleaning the steel to receive new paint?	Do you approve of sand blast method? If not, why?	Do you use spraying machine in this work?	For field coats what has your experience been in using carbon graphite or lamp blacks as a base? Which has given best results?	Remarks upon the subject of field painting in general are desired
D	E	F	G	H
Scrapers and wire brushes	Have used extensively and given satisfactory results, and recommend its use for clean old bridges	No	For some time have been testing various paints to adopt one as a standard. Tests not completed	
Putty knives, scraper and wire brushes	Our experience with sand blast cleaning is limited	We do not use spraying machines	No bridges on our line have been painted with carbon, graphite or lamp black	
Wire brushes	Have no objection to sand blast if closely followed by painting	We do not use spraying machines	As we uniformly use carbon paint for finishing coats, we have had no experience with graphite or lamp black	
Wire brushing and scraping	Yes, when available	No, use brush	Have used graphite successfully	
Hammer, chisel, brush	Yes			
Wire brush and scraper	Do not use	No	Both carbon and graphite	Graphite gives best results
Steel scraper and brush	Yes, for very rusty steel	No	Generally graphite	Advocate judicious touching up (every 2 years) to postpone date of complete repainting
Use hammers with chisel edge faces, placed at right angles. Flat knife scrapers and short steel pointed bars in corners and hook scrapers	Used some years ago, but abandoned for unsatisfactory results and expense	No	Graphite	
Scraping and pounding	Yes	No		
Steel scraper and brushes	Yes, when economical; experience limited	No		
Wire brushes	Do not approve of it	No	After some years of experience now use lamp black paint	Manufacture our own paints and believe we get better grade than obtained commercially
	Yes	No	Fairly satisfactory	Life of bridge depends upon proper painting, proper application and quality of paint used
Scrapers and brushes	Sand blast method is not approved	No	Our experience indicates the carbon paints give better results than graphite	
Steel brushes and scrapers	We do not approve of sand blast, as the cost is greater than its benefits	No	Have used all, not prepared to say which has given best results	
Wire brushes and broom	No	No	Graphite very satisfactory	
Hammers, scrapers, wire brushes, greasy portion cleaned with benzine	Its inconvenience and expense deters use of sand blast	Do not advise its use, as wasteful of material, and inferior work produced	Have received good results, using carbon, graphite or lamp black paints	Believe a mixture of lamp black, graphite and certain portions of inert materials gives best results

IRON AND STEEL STRUCTURES.

TABLE 4—QUESTIONS AND REPLIES RELATIVE TO REPAINTING OR MAINTENANCE OF BRIDGES UNDER TRAFFIC—Continued

Railroad	Mileage	Name and Title	What kind of paint do you use?	What determining factors decide the repainting of your bridges?	Generally, how often are your bridges repainted, and whether wholly painted or in part?
			A	B	C
El Paso & Southwestern	995	H. J. Simmons, Gen. Manager	Proprietary carbon and linseed oil paint	Failure of old paint as shown by inspection	Entire bridge 3 to 5 years one coat
Erie	2258	R. C. Falconer, Supt. Const	Proprietary anti-rust paint	Condition of structures	May be 4 to 5 years; we also do patch painting
Florida East Coast	694	A. H. Stead, Asst. Eng.	Standard yellow	Conditions	3 years
Grand Trunk	4765	H. B. Stuart, Struct Eng.	Carbon	Conditions	5 years
Great Northern	7804	J. A. Bohland, Br Eng.	Proprietary graphite and iron oxide paints	Conditions	About 8 years
International & Great Northern	1106	O. H. Crittenden, Chief Eng.	Graphite	Rust	Every 3 years
Lehigh Valley	1440	F. E. Schall, Br Eng.	Carbon or graphite	Condition of the metal	
Louisville & Nashville	4923	W. H. Courtenay, Chief Eng.	Red lead and graphite	General appearance	Every 5 to 7 years
Maine Central	1207	W. H. Norris, Br Eng.	Proprietary white lead and linseed oil paint	Rust and general wear of the paint	About every 4 years
Michigan Central	1817	Hans Ibsen, Br Eng.	Proprietary red lead, graphite and linseed oil	Whenever inspection shows need of repainting	Depends on location would probably average 5 years
Missouri, Kansas & Texas	3090	A. M. Acheson, Chief Eng.	Carbon paint	Condition of the old paint	Every 4 or 5 years
Missouri Pacific	7284	S. L. Wonson, Br. Eng.	Carbon paint	Condition of the old paint	From 8 to 10 years
Mobile & Ohio	1122	H. Austill, Jr., Br. Eng.	Proprietary carbon and linseed oil paint	Condition of paint	About every 4 years
Nashville, Chattanooga & St. Louis	1233	H. McDonald, Chief Eng.	Proprietary carbon paint	Amount of scale	Every 4 to 5 years
New York Central & Hudson River	3056	G. W. Kittredge, Chief Eng.	Red lead for retouching, standard asphaltum-varnish paint, and proprietary carbon and graphite paints	Condition of the paint	Every 5 or 6 years
New York, Chicago & St. Louis	523	G. H. Tinker, Br Eng.	Proprietary graphite and linseed oil paint	Appearance	3 to 5 years, bad spots more frequently
New York, New Haven & Hartford	2007	W. H. Moore, Str. Eng.	For touching up, red lead and linseed oil; entire bridge proprietary paints	When paint fails by showing rust spots, cracking or scaling	Average 5 to 7 years; part painting 3 to 4 years
New Zealand		James Burnett, Chief Eng.	Use red lead and hematite paints	When paint begins to blister or rust to show at rivet heads	Generally 5 to 8 years, and more frequently touched up

IRON AND STEEL STRUCTURES

TABLE 4 —QUESTIONS AND REPLIES RELATIVE TO REPAINTING OR MAINTENANCE OF BRIDGES UNDER TRAFFIC—*Continued*

What methods do you employ in cleaning the steel to receive new paint?	Do you approve of sand blast method? If not, why?	Do you use spraying machine in this work?	For field coats what has your experience been in using carbon graphite or lampblacks as a base? Which has given best results?	Remarks upon the subject of field painting in general are desired
D	E	F	G	H
Hand, scraping and brushing	Yes	No	Have used proprietary graphite paints with good results	
Wire brushes and scrapers	Have not used sandblast, never found it necessary to equip for same	No		
Scrapers and brushes	Yes	No	Never used	
Scrapers and wire brushes	Yes, for very rusty steel	Yes, for inaccessible parts	We found little difference between carbon and graphite paints which we have used	
Steel scrapers and wire brushes	No	Used it once, but contractor was required to follow with brush	We found very little difference between carbon and graphite paints which we have used	
Scrapers, chisels and torches	Have never tried	No	Have been using graphite with very poor results; I am thinking seriously of trying red lead as a field coat	
Steel brushes, chisels and chisel shaped hammers	Yes	No	Carbon and graphite paints are giving good satisfaction	Bridges exposed to salt brine drippings advocate red lead as a priming coat, and 2 coats of carbon or graphite paint
Wire brushes	No	No	Have not used carbon paints to any extent. Used graphite paints, lasting 5 to 7 years, but red lead and oil outlast graphite by 2 years	
Wire brush	Yes	No	We have had best results with graphite	
Scrapers and steel brushes	We have tried, but find it too expensive	No	Graphite has given us good service	
Scrapers and steel brushes	Do not advocate its use, except under special circumstances	Have not used and would not recommend its use	I have had best result with carbon paint	
Scrapers and wire brushes	No	No	As on new steel proper application in repainting is necessary but difficult to secure	
Hand scraping and brushing	No; too expensive	No; too expensive		
Knives and wire brush	Yes, but find it expensive	No	Carbon has given us good results	
Scrapers and wire brushes	Has been tried, but found troublesome and expensive	No	We have had excellent results with either carbon or graphite	
Wire brush, hammer and chisel	No; equipment is too expensive and cumbersome	No	No material difference between carbon and graphite	
Steel scrapers, putty knives, wire brushes, peen hammer and burners	On general principles, yes, but have not used this method	No	Advocate using red lead and oil first field coat and a carbon or graphite for second field coat	Proper cleaning before painting and not painting in frosty or extremely hot weather is essential for life of bridge
Steel wire brushes	We have not found the sand blast entirely suitable	No	Red lead base with oxide or hematite finish has given good results	

IRON AND STEEL STRUCTURES.

TABLE 4.—QUESTIONS AND REPLIES RELATIVE TO REPAINTING OR MAINTENANCE OF BRIDGES UNDER TRAFFIC—Concluded.

Railroad	Mileage	Name and Title	What kind of paint do you use? A	What determining factors decide the repainting of your bridges? B	Generally, how often are your bridges repainted, and whether wholly painted or in part? C
Norfolk Southern	817	F. L. Nicholson, Chief Eng.	Black carbon paint	When rust begins to show and the metal begins to scale	At tide water every two years; otherwise every three years
Norfolk & Western	2036	J. E. Crawford, Chief Eng.	Black ready-mixed paint	The appearance of rust spots	Generally every 5 years
Northern Pacific	6313	W L Darling, Chief Eng.	Our own special composition	General condition of the structure	In 5 to 15 years
Pennsylvania Lines West of Pittsburgh	3223	J. C. Bland, Bridge Eng.	Graphite or carbon	Pitting in paint or signs of corrosion in places	About 4 years
Pere Marquette	2330	C. S Sheldon, Eng Br. and Str.	Graphite our own formula	When they show rust or rust spots	We often paint the lower flange of plate girders
Philadelphia & Reading	1476	Wm Hunter, Chief Eng.	Iron oxide specially prepared	Condition of the metal	Every 4 to 8 years
St. Louis & San Francisco	4749	F. G Jonah, Chief Eng.	Composition paint of red lead, graphite, princess mineral with linseed oil	Blistering and scaling of old paint	At least every 5 years
St Louis Southwestern	1457	C. D Purdon, Chief Eng.	Proprietary carbon and linseed oil paint	Repainting is left to our superintendent of bridges	Probably every 6 years
San Antonio & Aransas Pass	724	J S. Peter, 1st Vice Pres. and Gen. Man.	Proprietary carbon and linseed oil paint	Signs of rust	Every 3 to 4 years
San Pedro, Los Angeles & Salt Lake	1100	R. K. Brown, Eng M. of W.	Touched up with red lead and linseed oil; whole struct. with black paint	We use our best judgment in deciding when to repaint	This varies, usually from 7 to 8 years
Seaboard Air Line	3082	E. A. Frink, Prin. Asst. Eng.	Proprietary graphite and linseed oil paint	General condition of old paint	Some bridges will run 4 to 5 years
Southern	7096	B. Herman, Ch. Eng. M. of W. and Struct.	Ready mixed red lead paint for retouching, and one coat of black carbon paint	Condition of steel	Every 5 years
Spokane, Portland & Seattle	556	W. E. Burkhalter, Bridge Eng.	Carbon and graphite	Before rusting proceeds to such an extent that steel cannot be cleaned by brushes	In general every 6 years
Union Pacific	3612	R. L. Huntley, Chief Eng.	Carbon	Generally brine dripping from refrigerator cars	About every 4 years

IRON AND STEEL STRUCTURES.

TABLE 4.—QUESTIONS AND REPLIES RELATIVE TO REPAINTING OR MAINTENANCE OF BRIDGES UNDER TRAFFIC—Concluded.

What methods do you employ in cleaning the steel to receive new paint?	Do you approve of sand blast method? If not, why?	Do you use spraying machine in this work?	For field coats what has your experience been in using carbon graphite or lamp blacks as a base? Which has given best results?	Remarks upon the subject of field painting in general are desired
D	E	F	G	H
Wire brushes	Under certain conditions I think sand blast very desirable	No	Best results obtained by using carbon paints. Under severe conditions have got good results by using asphalt paints	
Stiff wire brush	No; sand blasting leaves surface rough	No	Lamp blacks	Life of a bridge depends upon proper condition of steel to receive priming coat which should be red lead paint
Wire brushes and occasionally sand blast	Yes, sand blast properly used is best way of cleaning steel	No	Have obtained good results from carbon graphite or lamp-black paints. More depends upon cleaning of steel and application of paint	
Brush	No; in unskilled hands apt to cut the metal	Infrequently	So long as structure is kept fully painted there is little difference as to kind of paint used	
Scrape and brush	No; not efficient and too expensive	No	Graphite	Most important is spreading quality in extreme temperature and set reasonably fast. Proper condition of steel needed
Wire brushes	No	No	Have no experience with with material referred to	
Wire brushes and scrapers	Do not regard sand blast method economical	No	Have no data to compare carbon, graphite or lamp black paints	Proper condition of steel and application of paint essential to life of bridge
Steel brushes	Yes, on large bridges	No; found little economy in its use		
Steel brushes and scrapers	Yes, where sufficient work of this nature warrants the first cost	No	We find those with carbon base best for this climate	
Steel brushes and scrapers	Have never used the sand blast	No	Have only used red lead colored with lamp black	
Hand scrapers and wire brushes	Have had no experience but believe it is all right	No	My experience has been that graphite as a base gives best results	
Steel brushes and scrapers	No, on account of cost		Brand of paint is less important than proper cleaning of steel to receive paint. Failure has been by painting over rust, cinders or scale	
Wire brushes	Yes, where rust cannot be removed with wire brushes	No	Carbon and graphite have both been used with very good success	Proper cleaning of steel and application of paint are more important than the quality of the paint
Wire brushes and scrapers	Would use it on large structures—too expensive for small jobs	No	Have no preference in regard to carbon, graphite or lamp black	

DISCUSSION.

(Subject No. 3, Paint and its Application to Railway Structures.)

C. E. Smith:—The lines along which the committee proceeded were these:—The American Society for Testing Materials has had paints under way on wood and steel panels on the Atlantic coast and also for years on a bridge over the Susequehanna river. The work of this committee has been practically finished. Also a committee of the American Railway Engineering Association with which I worked, collected a lot of information and put it in the form of a report. I thought that, for the first year, it would probably be best, if the general results of the work done by these associations were put in as brief and concise a form as possible and published in the report of the committee for reference in future years. The first question that arose was whether or not any material already published in the other proceedings should be re-published in ours. As there are probably none of our members who are members of the American Society for Testing Materials, and but few are members of the American Railway Engineering Association, I would like the privilege of condensing this somewhat and putting it in the proceedings of this convention so that it can be used in future years.

The President:—Has any one any objection to this method of handling it? If not, it will be so handled.

C. E. Smith:—The tendency in the last few years has been to cover steel bridges with a thin cement or reinforced concrete coating, applied with the cement gun. The results of the application of this method on the Kansas City Terminal work, together with the costs of the application and the design of the encasements are included in the report. There have been many unfortunate experiences in the encasement of steel with concrete. In many cases the encasement has fallen off on account of the corrosion of the reinforcement. I believe there should be two systems of reinforcing, one to consist of a system of rods, ⅜ in. or ½ in. thick, or of sufficient thickness so that the corrosion will not be a factor, and the other a screen to hold the concrete in place, consisting of very fine mesh, attached to the heavy reinforcement. In future years it will not matter if the fine mesh corroded, as the concrete will be hanging on to the heavier bars and they would withstand the corrosion and stay there.

The President:—It would appear that some practical painters claim that the addition of a small amount of carbon paint in

the red lead paint sustains the lead, or stirs it up so much that it keeps the red lead in suspension better.

C. E. Smith:—That was mentioned by some who reported as having done that. No objections were reported.

Chas. Ettinger:—In the old method of making carbonate of lead it was necessary to add something to keep the lead in suspension. That, however, is not necessary today. The real technical and mechanical reason for adding a small quantity of lamp black, is that it acts as a guide. One has a coat of a perfectly red color. The specifications read that it must be applied to succeeding coats. Adding a small quantity of lamp black will turn it a darker brown color. The inspector will look at that structure and he can tell whether a portion or all of it may have been skipped. The Atlantic City paint tests to which Mr. Smith refers, where various panels of different steels were treated, showed that three coats do not stand as well as two coats of red lead, over which there may have been applied a coating of carbon. The reason is that red leads or a high grade of oxides are what are known as inhibitive primers; they have a tendency to retard electrolysis, which forms the combination to start corrosion. Carbon coatings contain more oil than red lead. They are, however, not inhibitive and will not stop electrolytic action.

Subject No. 4.

CARING FOR AND HANDLING CREOSOTED TIMBER.

REPORT OF COMMITTEE.

Timber has been and will continue to be one of the principal materials of construction employed in the bridge and building department. In spite of the inroads which steel and concrete have made in recent years there are many forms of construction for which timber is eminently superior to any other material. Its principal handicap is its limited resistance to decay. This has been overcome in a large measure by the injection of creosote oil, zinc chloride and other preservatives into the timber. The protection of timber in this manner has introduced new problems for the bridge and building workmen, the importance of which is not fully realized in all instances.

Starting with the open vat treatment of piling at the Gautier, Miss., plant of the Louisville & Nashville about 1870, the treatment of bridge timber to protect it against the agents of decay, has increased steadily until in 1915, 9,308,419 lineal ft. of piling and 142,009,041 ft. board measure of construction timbers (most of which was bridge timber) were treated by pressure processes, exclusive of a considerable additional amount of timber which was given open tank and brush treatments. Large as these figures are, that for piling shows a decrease of 2,612,182 lineal ft. from the record figure of 11,920,601 ft. established in 1914, although the quantity of construction timber exceeded the previous high record of 1913 by 180,459 ft. B. M. Over two-thirds of this timber was treated at plants located along the Atlantic and Gulf coasts although the material was used very generally over the entire country. Creosote oil was employed almost entirely in the treatment of piling, although zinc chloride and mixtures of creosote and zinc chloride were used to a considerable extent in treating construction timbers.

Starting with the treatment of piling for use in teredo infested waters and in locations with a moist, humid climate and a resulting short life of timber untreated, treated timber is now used very generally throughout all parts of the United States and Canada for a wide variety of purposes incident to bridge work. In probably its most complete and finished form it is seen in the ballast deck trestle of several western roads and in the creosoted timber dock in several Atlantic harbors. While not universally employed by any means (many roads use little or no treated timber) its use is increasing rapidly from year to year. One of the conditions leading to this increase is the constantly rising cost of the timber itself and the necessity of securing a greater life from it if it is to compete successfully with other construction materials. The agitation for the conservation of our forest resources has also been of some assistance in directing attention towards timber treatment.

The most important factor, however, has been the excellent result secured from treated timber. The Louisville & Nashville has been a pioneer in this work and still has in service in teredo infested waters along the Gulf of Mexico large numbers of piling treated in 1876 which have thus been in place for 40 years. Similarly out of 3,107 piles driven in the Galveston Bay trestle of the Atchison, Topeka & Santa Fe in 1895, over 90 per cent were fit for further use and were re-driven in other structures after being pulled in 1912 on the completion of the new causeway, whereas untreated piling in this same structure were eaten com-

pletely off by marine borers in two years. While not all results have been so successful these instances indicate what may be reasonably expected from the proper grades of timber, properly treated.

In considering the use of creosoted timber for railway structures it is well to determine how much one can afford to spend to secure permanent structures and just how permanent a railway structure should be built. This requires a special study of each individual structure. Much stress is laid on permanent construction for railway use today at the risk of unduly emphasizing it. If one will look over the history of our railway development he will be surprised to observe how short the life of a structure really is—not because of the character of the construction but from the fact that changed conditions and increasing business have made necessary the revision and reconstruction of the facilities. In many instances practically the entire railway property is rebuilt every 20 or 25 years. Under these conditions a careful analysis will show many times the inadvisability of spending any additional sum for an entirely permanent structure at a point where creosoted timber will give all the life that may reasonably be required. As this fact becomes more generally realized, treated timber will undoubtedly be used to a greater extent for many purposes.

While the subject of the proper treatment of timber is not included in the work assigned to this committee it is not out of place to call attention to a few essentials in the treatment as a prelude to its successful use later. In the first place only sound timber should be treated. Although this would appear to be axiomatic, large quantities of timber have been treated in past years and to a lesser extent are still being treated today, in which the decay is well advanced. It is only fair to state that this condition exists because of the inability of those in charge of the timber treating plants to detect such forms of decay rather than because of deliberate intent. It is only within the past few years that this condition has begun to be realized and many reported failures of creosoted timbers are not properly chargeable to the failure of the treatment but rather are the result of the treating of timber which was entirely unsound before the preservative was injected. Only a few years ago one superintendent of a large timber treating plant had reason to suspect the condition of a large amount of piling seasoning in his yard although there were no exterior indications of deterioration. He sawed a small amount from the ends of a few piles and was amazed to see that a large proportion of them were decayed within. Since that time all suspicious piling in this yard has been investigated in this way. For the same reason some of the railways have installed cut-off saws by means of which ½ in. of timber is sawed from the ends of each tie before it is treated as a check on the inspection.

With sound timber properly seasoned the treatment should be sufficient to insure the complete penetration of all sapwood and some entrance into the heartwood. If the heartwood is entirely sealed with preservative there need be little fear of decay. In general, piling and bridge timber should be treated to refusal.

After going to the expense of treating timber it would appear to be self-evident that it should receive no unnecessary abuse that would tend to render the treatment ineffective. Yet largely as a result of ignorance and carelessness one sees treated timber handled with hooks and cut unnecessarily on nearly every railway. If the character of construction is such as to warrant the use of treated timber, precautions certainly should be taken to avoid all unnecessary penetration of the protective surface. To gouge or tear the surface so as to expose the untreated timber at one minor point may be sufficient to start decay within the stick and lead to early failure of the entire piece. In spite of this only two or three roads have prepared any instructions for the guidance of workmen handling treated timber. Some rely on verbal instructions, which are unreliable at best, while others seem to have given the subject almost

no attention. The workmen should be made to realize that the preservative forms only a shell about the surface of the stick and that it ordinarily does not penetrate entirely through it. One of the most complete sets of instructions which have been prepared is that of the Illinois Central which is attached at the end of this report.

The problem is primarily one of education. Few workmen are so minded that they will deliberately destroy the property of their employers if this can be avoided readily. If the injury resulting from the cutting of treated timber is pointed out to them and they are shown how to avoid this damage, most men will co-operate in eliminating this unnecessary destruction. The superintendent of treating plants of one important road has effected a material improvement in the practices of this road by collecting a large number of photographs showing the manner in which treated timber has been abused on that line which he has incorporated in a talk to give to the men at the different division headquarters. Such measures coupled with disciplinary action for the man who will not respond to educational measures will eliminate a large part of the mutilation of treated timber found today.

The problem is not alone one for the men to solve, however. The timber must come to them in a condition requiring the minimium practicable amount of framing in the field. This has led to the framing of a large amount of timber before treatment, a practice which is receiving serious consideration on several roads today. At the Gautier, Miss., timber treating plant of the Louisville & Nashville, which treats bridge timbers only, a carpenter shop has been installed at which all timbers are fully framed before they are treated. As a result the cutting of the timber after treatment is reduced to the minimum. Similarly on the Santa Fe where large numbers of treated timber box drains and culverts are used, the timber is framed and sawed to the length desired before being treated.

On the Philadelphia and Reading the chief engineer furnishes the creosoting plant with the details and framing instructions for all timber used on new construction work and this timber is framed at the creosoting plant before being treated. Similarly when the proper arrangements can be made, the division engineer furnishes the timber treating plant with detailed drawings of timbers required for maintenance of way work and they are framed in a similar manner.

Even with the most careful precautions it frequently becomes necessary to bore into timber or to cut it when using it in the field. The problem then is to protect it and duplicate the original treatment as far as possible. It is the quite general practice to fill all bored holes with hot creosote and to apply coal tar or preferably hot creosote to all cut surfaces. This treatment should be applied to all surfaces which have been cut whether they show untreated wood or not. On one or two roads, a coat of hot pitch is applied after the creosote as a seal. The importance of protecting all cut surfaces should be thoroughly impressed on the workmen for the neglect of one small cut may mean the early decay of an entire stick.

Care should also be taken to avoid the use of treated and untreated material in the same structure. Instances are frequent where a workman runs short of treated material and thoughtlessly fills out with untreated timber, or applies a brush treatment to sufficient timber to complete the structure. The usual result of this action is to reduce the life of the adjoining treated timber if not of the entire structure almost to that of the untreated timber, by affording lodgment for the fungi in the unprotected wood from which they spread to the adjoining treated sticks. This is forcibly illustrated by the accompanying photograph of a creosoted drain box in which the center of the top was filled in with two untreated planks which supported a luxurious growth of fungi. To make matters worse the treated timber had been sawed after treatment and these fungi came directly in contact with the untreated ends

1.

1. Section of treated timber exposed by cutting after treatment.

2. Section of drain box. Lower portion shows two untreated planks in this box which failed.

of the treated timber. It is not, therefore, surprising that this box failed after four years. This condition was only brought to light by the reported failure of the treated timber.

Piling requires special treatment according to the conditions under which it is to be used. Nearly all piles treated receive creosote as the preservative. Where they are to be used in water infested with marine borers, special attention should be given to see that they do not contain pitch knots or other blemishes which will retard the penetration of the oil. Care must also be given to see that the surface is not injured in handling. Experiments now being conducted by the United States Bureau of Fisheries in conjunction with the Forest Service on the resistance of treated piling uncovered and also sheathed with untreated timber show the unsheathed piling to resist the borers while that incased in untreated wood is riddled by the teredo and xylotrya. The explanation of this fact is offered that the borers enter the wood when small and easily killed by the poisonous creosote, but that they attain a considerable size while passing through the untreated wood and are then able to resist the poison when they reach the treated piling inside the sheathing. It is, therefore, highly important that the surfaces exposed to attacks of these borers be thoroughly treated and that they be given no opportunity to secure a foothold.

For the same reason that it is advisable to apply a brush coat to all cut surfaces of stringers and framed timbers, pile heads should be protected after being cut off. The inconsistency of leaving the head of a pile unprotected after treating the stick carefully, is so evident as to require no argument. Yet this is frequently done in the field. To

protect them the exposed tops of piling are commonly mopped with hot creosote. The Atlantic Coast Line applies a paste of coal tar and lime on those piles handled by company forces while the specification inserted in contracts for the building of structures by other than company forces reads as follows: "If untreated wood is exposed on any piece of creosoted timber or piling in framing, boring bolt-holes, etc., the untreated part must be painted, when dry, with at least two coats of warm creosote. In addition, piling cut-offs must be covered with a paste of coal-tar and lime." The Southern requires the heads of the piles to be coated with hot creosote, followed by an application of coal tar pitch of such consistency that it will remain elastic at the lowest temperatures encountered.

In addition to the avoidance of all unnecessary cutting into treated timber, care should be taken in handling it to and from cars to avoid penetrating the treated surface. Heavy timbers should not be thrown from a car, as this tends to split and break them. Neither should they be handled with sharp pointed grab hooks or peavies. A number of roads use skids to transfer such timbers from pile to pile and to and from cars. Heavy slings are also used in place of grab hooks. While this may require some special attention at first, after such practices become standard, and the men become accustomed to them, little if any additional time or exertion is required.

Creosoted timber presents a special fire hazard, particularly shortly after treatment. Precautions should be taken to see that only the amount of oil be injected into bridge timbers which they will retain without the collection of excess oil on the surface. Until this surface oil has evaporated and the timber is dried out, the inflammability is increased but after this time tests have shown that the resistance to fire is increased slightly as compared with untreated wood. However, when once a fire is started in creosoted materials it is exceedingly difficult to put out. Because of this fire hazard, the treating plants desire to ship creosoted material to the site of the work as promptly as possible to avoid its accumulation in large quantities in the central storage yard.

When stored along the line, it should be piled solidly so that it will not dry out too rapidy, and should be covered with a light layer of dirt for the same reason and as a protection from sparks from passing locomotives. All grass and other combustible materials should be kept cleared away from the piles. Piling intended for use in water infested with marine borers should not be piled in the sun for any length of time as the oil evaporates and the resistance of the pile to the borers is decreased. In one instance treated piles which were left on the bank for two winters and one summer were destroyed by marine borers in less than five years, while others of the same kind and treatment which were driven soon after being treated were attacked very slightly. This also probably explains the fact that the marine borers frequently attack one side of a pile more severely than the other.

Closely allied with the adoption of methods to secure full service from treated timber is the investigation of all failures to ascertain their cause in order that similar conditions in the future may be avoided. While the scientific investigation of these failures will in most cases be made by the engineer in charge of timber preservation for the system, he must depend on the local supervisors of bridges for notice of failures and for data regarding the service rendered and any conditions leading to failure. Too frequently treated timber which has failed to give satisfactory service is removed from a structure and destroyed without an examination being made to ascertain the cause. The result of a multiplication of such instances is a prejudice against all treated material and perhaps the discontinuance of its use. Treated timber has been used successfully too long to justify its wholesale condemnation in this manner, and the road which takes this action does so to its own detriment. On those roads on which no timber is destroyed until the reasons for

its failure have been ascertained, the number of such failures reported has decreased very materially. It has been the experience that a very large proportion of those reported have been found to be due to other causes than the treatment, and in numerous instances the timber reported as treated timber was never treated at all. It is only by such investigations that the reasons leading to premature failures may be ascertained and the contributing conditions corrected.

ILLINOIS CENTRAL RULES TO BE FOLLOWED IN HANDLING CREOSOTED MATERIAL.

1. The ground on which all creosoted material is to be unloaded shall first be thoroughly cleaned of all dead grass and rubbish for a distance of at least 20 ft. from any part of such pile.

2. When creosoted piles are unloaded at a bridge, they shall be placed at least 100 ft. therefrom. No skids or separating strips should be used, but the piles should be placed directly on the ground and piled compactly. If the ground is muddy or wet, it will have no effect on the creosoted material. When there is more than one stack of piles, each stack should be separated by at least 50 ft. Where possible, there should not be more than 25 in each pile.

3. Creosoted material should not be piled on the side of the track on which telegraph lines are located.

4. All other creosoted timber should be piled on the ground without skids and separating strips. Where there is more than one tier of any size the vertical space between the pieces should be as small as possible so as to prevent hot cinders lodging. No tiers should be higher than 3 ft. Piles of timber should be as small as permissible and the piles should be separated from each other by not less than 50 ft.

5. Creosoted piles, when driven for renewing bridges, must be cut off immediately and not be allowed to stand on account of the fact that the tops of creosoted piles after being driven are always more or less battered and in such condition that the smallest spark will set them on fire. Serious fires have occurred which were due to the above cause entirely.

6. All bridge employés should exercise great care to properly protect all creosoted bridges from fire, and see that water barrels are placed on bridges in accordance with rules covering this matter, also that all grass and rubbish is entirely removed from under and around bridges.

7. Under no conditions should creosoted material be placed in the same pile with untreated material.

8. In all cases where it is found necessary to frame creosoted timber and where creosoted piles are cut off, immediate provision must be made for thoroughly coating the cut ends with hot creosote oil.

9. Creosoted structures should be inspected and watched with as much or more care than structures built of untreated material. In inspecting creosoted piles and timber, borings should be made with a 7/8 in. auger, and if the material is found to be sound, the hole thus made should be filled with a creosoted plug 1 in. in diameter, driven to the bottom of the hole and cut off flush.

E. T. Howson, Chairman.
J. S. Lemond,
F. D. Mattos,
Committee.

DISCUSSION.

(Subject No. 4,—Caring for and Handling Creosoted Material)

E. T. Howson:—I would like to emphasize the latter part of the second paragraph, on the second page of the report. During recent years the concrete people have conducted a very able and aggressive campaign of publicity in favor of permanent structures. I think they are subject to commendation rather than criticism because of their business foresight, but at the same time they have carried many people off their feet to a certain extent and have led them to build structures at increased cost, that are more permanent than conditions justify in some instances. It is not economical to build a structure to last 50 or 75 years, when past history and the information one can secure indicate that it will probably have to be rebuilt in 25 years because of changed plans or the need of increased facilities.

The President:—This paper is probably as able as any one could write, but I feel that there are a number here who may like to ask some questions about it or relate their experiences along the same line. We will be glad to hear from anybody.

It seems to me that the point most worthy of discussion on this subject is the abuse of the treated timber on the average railroad. Some men will say they don't abuse treated timber, but all one has to do is to go out on the line and he will see the gangs sawing the ends off treated timber, etc. We all know that treated timber costs money. We put a shell of oil around a stick and the men in the field then proceed to cut it off. One has also to use sharp pointed tools with judgment. The part of a pile that goes below the ground serves under different conditions than the part above, and sharp pointed hooks can be used here in moderation.

Three conditions are necessary for decay—heat, moisture and air. A certain distance below the ground eliminates one of these conditions.

C. H. Fake (M. R. & B. T.):—I would like to ask if the committee has any information regarding the use of untreated and treated stringers in the same structure and if the treatment to some extent affects the strength of the timber. In many cases it is desirable to use treated piles and treated caps, and perhaps to cover the caps with sheet iron. Has the committee any information as to whether the fungi would be communicated from the untreated stringers to

the treated caps and treated piles underneath, particularly where they are protected by galvanized iron?

The President:—In order not to take too much time I might say that the treating of stringers does weaken them, but only a small amount; not enough to affect the factor of safety. In 1896 we treated a mile or two of stringers on open deck trestles and have had them in use ever since, and we found no more broken stringers among the treated ones than there were among the untreated ones; in fact I think there were less broken among those treated than among those untreated.

C. R. Knowles:—As I understand the subject the framing of creosoted timbers in the field, forms one of the abuses of such material. We have three different sizes of wood tanks and towers on the Illinois Central. The timbers for these tanks and towers are all framed at the creosoting plant at Grenada, Miss., and it is seldom necessary to even bore a hole in the timbers during construction.

C. H. Fake:—Can the timber be framed before treating and, after treating come out in good condition for putting in the structure? Is the treatment liable to warp or cause trouble of that kind?

C. R. Knowles:—As far as our tank frames are concerned it is possible to treat every portion of the frame. We have these frames treated and kept in stock at our treating plants all the time. They are used for renewing tank frames as well as for constructing new tanks. I know of any number of frames erected where it has not been necessary to do any cutting whatever in the field.

The President:—We realize that it is impossible to drive piles in a trestle so that the timbers can be treated before they go in, and be of exact length, especially if one is driving through an old trestle. In structures on our road where treated stringers are applied if any have been driven very badly as to spacing, a complete new bill must be made up and a special deck made; but in case one can get along without cutting off more than 2 or 3 in. of the stringers, we permit that, and an extra coating of oil is put on after they are cut; our understanding being that the creosote will penetrate from the end of the stringer at least two or more inches.

C. W. Wright (L. I.):—One feature that has not been brought out is the importance of using ample tie plates where creosoted bridge ties are used. Our road had a rather interesting experience when the ties on a certain elevated structure, framed before creosoting, and furnished with small corrugated tie plates, had their life shortened probably 30 per cent by rail-cutting. I do not think it is

possible to get as good results by using small tie plates on creosoted bridge ties as on those untreated.

E. T. Howson:—I think the point Mr. Wright brings out applies not only to bridge ties but to all ties. We commonly have too small tie plates rather than too large.

The President:—I would like to ask Mr. Gratto to tell what we do on our road in handling treated timber.

J. Gratto:—Our instructions are to not cut creosoted material under any circumstances except to saw off the head of a pile to the required height. Bridge ties and caps should not be creosoted. We have tried them to a finish. I believe that every stick that is creosoted should be framed before creosoting. We have locations on our line (on the Tuscon branch) where an untreated pile will last as long as a creosoted pile. There is something in the ground that causes the latter to decay. The piles decay from the inside while the outer shell may be perfectly sound. One may strike them with a hammer and determine that the heart is entirely gone. Down near San Pedro we built bridges of creosoted material in 1879 from which we took the stringers out this summer and found them to be in good condition.

E. T. Howson:—The point made regarding interior decay is illustrated by the yellow pine exhibit in the next room. The decay arises largely from improper seasoning before treatment. There is also a type of decay recently discovered that shows no exterior indications. One road found 300,000 ties that it had to lay aside, as absolutely worthless for treatment, because of the same condition found in the piling,—interior decay. That form of decay is particularly active in the southern timbers that lie in the woods 3 or 4 mo. from the time they are cut until they are taken into the treating plant.

The President:—Mr. Plank took out the wharf Mr. Gratto referred to and I think he will confirm the statement that in every case where the pile was eaten, the borers had gained access through some defect in the pile.

D. E. Plank:—About 35 per cent of the piles were good. The wharf is in an open roadstead. In a few cases the teredo got into the piles and then went from top to bottom.

W. M. Clark:—The chairman of the committee said that the trouble was in improper seasoning. I would like to ask the proper way of seasoning timber before creosoting.

E. T. Howson:—The difficulty has been, in the instances called to my attention, that the timber has been allowed to lie in the woods

after being cut and surrounded by a luxurious growth of fungi, which at once began to attack the timber. There have been important developments in the sanitation of lumber yards in the last few years. The modern lumber yard is a material improvement over the old lumber yard, in making provision for means to resist the attacks of the agents of decay. The yard is kept clean of the luxuriant growth of vegetation. Cull timbers are used as sills on which to pile the creosoted timber.

The President:—In the treatment of Douglas fir piling it is customary to give them an artificial seasoning in the retort. In treating a retort full of piles one may find quite a number that are entirely different in character from the remainder in the cylinder. In the artificial seasoning a vacuum or condenser drains the sap or moisture from the piles, and this vacuum is run long enough to take out practically all of the moisture. It may be that at that time every bit of moisture is out of 90 per cent of the piles, and practically all of it is still in 10 per cent of them. Then the creosote is injected into the piles, and this ten per cent of the timber gets none of it, or if it does get it the moisture that is in the interior of the pile is enclosed by the band of creosote in the sapwood on the outside. Unfortunately in some plants there is a tendency to put as many piles through the plant as possible in a day, and one is very apt to get a small proportion in each lot that will not have the same treatment as the others. There is an attempt to correct this by picking out all piles of a retort charge from the same cut and the same general conditions, but this is not always possible.

W. M. Clark:—The gentleman said that the timber was allowed to lie in the woods, surrounded by growth. Would it not be possible to put it up on something in the woods and allow it to season artificially where it is, keeping it off the ground so that vegetation will not be around it?

E. T. Howson:—One difficulty would be that as the timber is cut in the southern pine woods, it is in the midst of other timber. When you take it out for seasoning take it to a place where you have free circulation of air.

Subject No. 6.

MODERN METHODS OF DRIVING PILES.

REPORT OF COMMITTEE.

While the subject of this report is "Modern Methods of Driving Piles," it may be interesting to go back for a moment. The earliest use of piles was to support dwellings above the surface of lakes or marshes in a manner which is still common in the Philippine Islands and other parts of the world. About sixty-five years ago there were discovered in the lakes of Switzerland many thousands of such piles together with the remains of houses containing household utensils and tools of people of the stone age of human development. It was very evident that the piles had formed the foundations of these ancient houses. Herodotus describes the dwellings of the Paeonians who lived on Lake Prasias in Macedonia, some 2,500 years ago. The houses were built on platforms resting on piles which were placed, at first, by the community as there was need for them and later by individuals as a marriage tax.

The foundation of the great Campanile of St. Mark's at Venice, which was built early in the twelfth century, rests upon poplar piles driven into, but not through, a thick bed of clay overlying sand. In 1902, the old Campanile fell while repairs were being made. The piles in the foundation were found to be in good condition and form a part of the foundation of the new Campanile.

Probably the first pile drivers were mauls in the hands of men and these may have been followed by rams but vertical leads guiding a weight which was raised and lowered by men pulling a rope attached to it were a very early development. The steam hammer was invented in 1845 and the water jet was first used about 1852, so it will be seen that the term "modern" as applied to piles and pile driving may cover quite an extended period.

It has been the purpose of this committee to learn the present practice relating to pile driving on the railroads of the United States and Canada. To this end, letters containing questions, intended to direct the nature of the replies to some extent, were sent to the chief engineers of about 90 different lines. Replies have been received from 56 and we wish here to thank these chief engineers and others and also the manufacturers who furnished information for this report. There has been a good deal of periodical literature relating to piles and pile driving in recent years but to a considerable extent it concerns concrete piles and relates to larger projects than are undertaken by railroad companies with their own forces. Most of the members of this Association have access to one or more of these periodicals so that it has not seemed expedient to quote such articles although reference is made to two or three. This report is confined to the consideration of methods of driving wooden piles.

Track pile drivers are of two general types: turntable drivers and boom drivers. In some locomotive crane drivers these features are combined. Turntable drivers are in more common use but the boom driver has a number of advantages.

There are several types of turntable drivers, the chief difference being in the relative arrangement of the engine and boiler with respect to the turntable feature. The engine and boiler may be mounted and fixed on one end of the car and the turntable and leads toward the other end; the engine and boiler may be mounted at one end of a false floor or deck and the leads at the other end, the whole acting as a turntable supported at or near the center of the car; or the entire machine including the car may be mounted on a turntable which rests on the track when in use, but otherwise is suspended from the bottom of the car.

In the early days of railroad pile driving drivers were frequently built in company shops. Today, there is less of this and machines are more commonly purchased from manufacturers. Some of them are illustrated on the following pages. They are built to meet special requirements when desired. In general they are of standard all-steel construction and are equipped with air pump and brakes for operation separately or as part of a train. They are self propelled, power being supplied from the engines through shaft and gear connections to the car wheels. They can run at speeds of from 8 to 25 miles an hour and some can haul several cars. The turntable is turned or shifted and the leads raised and lowered by steam power under the control of the engineer. The leads may be battered in two or three directions, usually by hand operated mechanism, and either a steam or a drop hammer may be used in them. Idlers are required at one end when moving these cars in trains.

A turntable driver of the first type mentioned above is shown in Fig. 1. This car has a locomotive type boiler. The slewing motion of the leader truss may be used for straightening piles and is equipped with an auxiliary hand-operating device for small movements. The forward reach is from 16 ft. to 20 ft. and the side reach about the same.

An illustration of a turntable driver of the second type appears in Fig. 2. On this car a vertical type boiler is used. Two sets of engines are provided, one of which operates the propelling and slewing mechanism and raises and lowers the leads, while the other operates the hammer and pile lines. Piles can be driven from either end of the car at a distance of 20 ft. from the center of the forward axle while the maximum side reach is 33 ft. 9 in.

Some of the locomotive crane drivers belong to the second type of turntable machine. They have a built-up leader truss which supports the leads. The leads are adjustable to a batter and the power of the crane may be used to straighten up piles that are inclined to go in the wrong direction. These drivers have an extremely long reach. Those on the Burlington have a forward reach of 21 ft. and a side reach of 39 ft. In addition, piles can be driven at either end of the car, a feature which is sometimes very advantageous on emergency work. When not in use as a pile driver, the leader truss may be removed and a boom substituted. The same leads can be swung from the end of the boom. This type is shown in Fig. 3.

A driver which combines the features of the first and third types of turntable machines is illustrated in Fig. 4. The leaders are hinged to a pair of counterweighted trusses mounted on a turning mechanism at the forward end of the car. The boiler is of the locomotive type and is placed at the rear of the car. The engines are geared directly to both the forward and rear trucks and the car can move under its own power at the rate of 25 mi. per hr. The distinctive feature of this driver is a turntable which is hung from the center of the car body and which, by means of hydraulic lifting cylinders, will raise the entire car from the track, so that it may be turned end for end. It is stated that this operation can be accomplished in about 10 minutes. While the car is standing on the track, piles may be driven on a radius of 21 ft. from the center of the forward axle. When the track turntable is used, the maximum reach is 32½ ft. from the center of the turntable.

A driver of the second turntable type has been designed and built by the engineering department of the Chicago, Milwaukee and St. Paul. A feature of this driver is a pair of rockers which serve as a support for the leaders while they are being raised and lowered. The driver is self-contained and no idler is required when it is being moved over the road. The forward reach is 18 ft. and the side reach 20 ft. Fig. 5 shows one of these drivers handling 70 ft. piles on track elevation work at Milwaukee.

The Grand Trunk is also using drivers of its own design built in company shops. There is an auxiliary deck carrying the leads, boiler and engine, which swings about the center of the car. The leads are so hinged to the frame that they may be raised or lowered by shifting the hammer. The driver can be made ready for movement in 30 to 40 seconds after driving is stopped, and work may be resumed as quickly. The car is propelled by double reversible engines attached to the under side of the car-sills and connected to the axles. It is equipped with air brakes.

We pass now to the boom type of driver. Good examples of this class are in use on the Illinois Central, having been designed in the engineering department and built in the company shops. These cars are really bridge erection derricks and are used to a considerable extent for that purpose and for handling and unloading heavy material. The pile driving equipment consists of a set of leads swung from the end of a 40 ft. boom for use with drop hammers and a 50 ft. boom for use with steam hammers. Piles may be driven 30 ft. ahead of the forward axle and 21 ft. from the center of the track, provided an outrigger consisting of block and falls is put out on the opposite side. The latest of these cars are built entirely of steel with the exception of the floor and house. They are equipped with chain propellers and air brakes and some of them have sufficient air capacity to supply power to pneumatic tools. An illustration of an Illinois Central boom driver is shown in Fig. 6.

A special rig of this kind designed for driving 70-ft. foundation piles from track level on the Chicago, Milwaukee and St. Paul is shown in Fig. 7. The boom of this car was built up of steel pipe. The 76-ft. leads were pin-connected at the top and were connected to the bottom of the boom by an adjustable steel frame. With this equipment, 30 long piles could be driven in a 10-hour shift.

A locomotive crane with leaders suspended from the boom forms a satisfactory driver for many purposes. With it piles may be driven in any direction from the car. It is possible also to drive piles with a steam hammer suspended from the end of a boom without leads. Crane drivers of this kind are largely used by contractors.

Another adaptation of a machine designed primarily for another purpose is shown in Fig. 8. A pair of leads is suspended from the end of the boom of a ditching machine. The leads are attached at the bottom to the base of the revolving deck by means of an adjustable platform. Piles can be driven at a radius of 20 ft. from the center of the machine and this permits of bents at 15-ft. centers. The ditcher may be operated as usual on a track laid on a flat car or on rails laid to wide gage at track level. Leads 40 ft. long and a 2,000 lb. hammer may be obtained with this machine. It is claimed that such an outfit is well adapted to the needs of small roads.

There are many desirable features on these modern cars but probably the self propelling device is as valuable as any. With a car so equipped it is possible in many situations to dispense with the use of a locomotive. On busy lines it is usual to confine independent movement to short distances—say one-half mile—and frequently short side tracks are laid near construction jobs to accommodate the driver. On light traffic lines, it would appear that the propeller might be used for greater distance. Use can be made of such a driver in material yards for shifting cars and the boom type of drivers especially valuable for this work.

Some drivers have a very long reach. One that will reach a second bent ahead is a great aid in emergency driving after a fire or washout A wide side reach is valuable on three and four-track lines and for such use those drivers which have little overhang at the rear are advantageous.

The ability to operate the turntable mechanism and raise and lower the leads by hand as well as by power is a feature of some machines. A boom supported at the foot of the leads when raised, or on the hammer, is a handy contrivance for lifting bridge timbers, and electric lights for night driving are desirable. These have been applied by the Union Pacific to one of their drivers.

An example of work accomplished with a good pile driver is the following from the Gulf, Colorado and Santa Fe: "In the building of an open deck pile trestle in re-establishing rail communication with the mainland at Galveston after the 1915 storm, we drove 270 four-pile bents with one driver, driving every pile to place and giving very good cap bearings, in 9 days of 24 hours. Two shifts were used, working 11 hours each with 1 hour lay off. A drop hammer driver at the other end of the gap was considerably less efficient."

For driving piles in foundations beyond the reach of the track driver the most common practice is the use of the ordinary land or creeper driver, which consists of upright leads placed at the end of a pair of sills with a hoisting engine and boiler mounted on a platform at the opposite end of the same sills. In some cases power is furnished from a track driver and occasionally horse power is used. The driver is mounted on wheels or rollers, or hickory skids may be attached to the under side of the sills. The size of the machine varies with the nature of the work to be done and the weight of the hammer used is generally less than on track drivers.

Other methods employed for driving foundation piles are the suspension of leads from the boom of a track derrick, or of a stiff-leg or guy derrick placed on the ground or on barges; the extension of the leads of a track driver to reach the foundation pit; or leads may be suspended from the superstructure.

As with foundation piling the kind of equipment used for marine work depends on the nature of the work and the number and length of the piles to be driven. For heavy work fixed leads mounted on barges of from about 20 ft. by 50 ft. to 30 ft. by 60 ft. in plan, and 5 or 6 ft. deep are used. The engine, boiler and housing are located on the barge to properly balance the leads and hammer. Power winches should be provided to hold the barge in proper position. If battered piles are to be driven the leads may be suspended near the top from a fixed A frame. Some roads use, in place of the fixed leads, a land driver similar to that described above mounted on a barge and one of the committee's correspondents expresses a preference for this type when it is not necessary to pull any piles.

For lighter work smaller barges which may be shipped on flat cars are convenient. On the Florida East Coast Ry., these are made 9 ft. wide by 30 ft. long. Four of them are placed together in the water and a creeper driver is supported upon them. A creeper driver supported and launched ahead on piles as driven may also be used. For dock work it is sometimes possible to use a land driver on the bank, skidding it sideways as the work progresses. Where conditions permit one may follow the practice of the Detroit and Mackinac Ry. and drive piles for docks and pier protection with a land driver resting on the ice.

Steam hammers are in use and are recommended for certain classes of work on 31 of the 52 lines answering the committee's inquiry. A decided preference is shown for medium weight steam hammers. It does not seem that there can be much difference of opinion about this. The heaviest hammers are more difficult to handle and when near the top of the leads increase the tendency of a driver to overturn. In addition there

are not many situations in railroad practice where the medium weight hammer will not handle the work.

The minimum weight of drop hammers on track drivers is about 2,000 lb. In general, railroad companies are using hammers weighing from 2,800 lb. to 3,500 lb. although seven of the roads reporting to the committee are using heavier hammers for some of their work, mention being made in one case of a hammer weighing 4,500 lb. As a rule heavier drop hammers are used on floating drivers of permanent construction than on track drivers and lighter hammers are in use on land drivers.

While the steam pile hammer was invented in 1845, its adoption by railroad companies has been comparatively slow. Some roads that have used both steam and drop hammers continue the use of the latter for certain classes of work, while others use them entirely, believing that they secure better results than with steam hammers. Some other companies have never used steam hammers and continue the use of the drop hammers because they are satisfied with the work done by them; or because of light traffic or the small number of piles to be driven the purchase of a steam hammer does not seem justified. The drop hammer also has the advantage of less weight and greater ease in handling.

Jacoby and Davis in their book on "Foundations of Bridges and Buildings" state that "the following advantages are claimed for the use of the steam hammer by those who have also had experience with the drop hammer: (1) The pile is held in position and guided more firmly while driving, thus keeping it from dodging, or getting out of line, and avoiding the labor of toggling. (2) Serious damage to the pile such as brooming, splitting, etc., is avoided. Hence piles of softer wood may be employed. (3) Extra time and cost for the use of a ring on the pile head is saved. (4) The driving is equally effective for any position of the pile head in the leads. (5) A pile may be driven several feet (7 or 8 ft. with some hammers) below the bottom of the fixed leads without the use of extension leads. A few feet may often be saved in cut-off by thus driving below the elevation of rail. (6) When driving into soft material or into sand, the rapidity of action keeps the pile in motion and prevents the earth from recompacting around the pile until the driving ceases, thus reducing the frictional resistance. (7) More piles can be driven in a given time and often with a smaller crew. (8) The steam hammer has been used effectively in places and under conditions where it was found to be impossible to use a drop hammer successfully. This relates to cases of limited head room as well as to difficult subsurface conditions. (9) Less injury is caused to adjacent foundations, and less breaking of glass and plastering in adjoining buildings. (10) The leads last about three or four times as long as when a drop hammer is used. (11) On track pile drivers less injurious strains are caused in the car and machinery, thus reducing the cost of maintenance. (12) Although the first cost of the steam hammer is much greater, the total cost of driving is reduced."

When a pile cap is used with a drop hammer the advantages mentioned under (1) and (3) and to some extent under (2) do not hold and there are also restricted situations (8) where a drop hammer would be more effective than some types of steam hammers. There is considerable difference of opinion among the committee's correspondents in regard to the results obtained with steam and drop hammers as is evidenced by the following:

Atlantic Coast Line:—The steam hammer is preferred as the driving is quicker, more uniform, and the pile is not so badly damaged.

Boston and Maine:—We think that the steam hammer injures piles less, is conducive to ease in driving and is more economical in the use of steam.

Central of Georgia:—A steam hammer is preferred as it does less damage to the piles.

Chicago & Eastern Illinois:—Steam hammers are the only ones to use. Good, quick, cheap and the best results are obtained.

Denver and Rio Grande:—Our principal reason for the adoption of a steam hammer on a track driver is that better penetration is secured without injury to the pile.

Ft. Worth and Denver City:—On this line we have four rivers that are mostly quicksand. We drive piles in them as long as 50 ft. and find that we can drive them cheaper and better with a steam hammer.

Gulf, Colorado and Santa Fe:—We use the steam hammer because it has proven to be the quickest and safest and it drives piles more accurately to place.

Illinois Central:—We can obtain as efficient work with drop hammers at less expense in driving timber piling and for this reason they are used. Drop hammers are not as good for driving concrete piling as steam hammers.

Lake Erie & Western: A drop hammer is easily handled and satisfactory when driving from the track, and is also best suited when driving piles in clay.

Louisville & Nashville:—A drop hammer gives more satisfactory service and enables better penetration to be obtained.

Minneapolis & St. Louis:—A steam hammer does much better and quicker work where it can be used, but it is too heavy to move easily on an ordinary land driver.

Missouri, Kansas & Texas:—A single or double acting steam hammer is economical and does quicker and more thorough work.

New York Central (Lines West):—Drop hammers are used on account of their low cost, and ease of handling on a track or land driver; also they will sometimes drive piles in hard soil where a steam hammer will not drive them clear down to place. The steam hammer is used in many places in sand and quicksand, especially in connection with a water jet. By this means, piles can be driven much faster and left in better condition after driving than with a drop hammer.

Norfolk & Western:—Steam hammers are best for use on soft wood piles on the sea-coast and drop hammers on hard wood piles in the interior.

San Antonio and Aransas Pass:—It is found that by protecting piles with a follower or with pile rings the drop hammer will give better penetration in less time than the steam hammer in the same class of material.

Seaboard Air Line:—The steam hammer for a track driver is more economical, and gets a deeper penetration of the pile with less brooming and damage, and better position. On marine drivers operated on sea water the action of salt water is apt to seriously affect the encased parts of the steam hammer. On this account we prefer the drop hammer for marine drivers.

St. Louis & San Francisco:—We have been able to get better penetration with the steam hammer and save considerable money by its use.

The usual method of attaching a rope pile line to the pile is by means of a short piece of chain with a hook at the free end. When a wire cable is used as a pile line, the chain is sometimes dispensed with, the hook being attached directly to the cable. Care should be used in placing and fastening the chain around the pile, particularly when handling freshly creosoted piles. The Boston and Albany uses a snatch block at the lower end of the leads through which the pile line is passed when the piles are some distance from the track, thus preventing a side pull against the top of the leads.

Practice in regard to the assignment of drivers to divisions or to the whole line is not uniform. For the most part, drivers are assigned to the whole line although on some of the larger roads a driver is assigned to each division but is moved to nearby divisions if there is occasion for

it. In addition to the division drivers, there are sometimes additional drivers which are assigned to the whole line and used where there is a large amount of work, or on construction jobs.

Where drivers are assigned to divisions the pile driver crew is more or less permanent, but where assigned to the whole line the more common method is for the engineer only to accompany the driver. It is claimed by some that better driving results from this arrangement—presumably local pride has an effect. On the Illinois Central, where the whole line drivers are used largely as erection cars, and on a number of other lines, crews are regularly assigned with the drivers.

Pile driver crews vary in size from 6 to 15 men, the average being 10 men. This does not include a night watchman. The average number of men on roads using drop hammers only is 10½ and on roads which use both steam and drop hammers, 9½. The committee can not say that this is due entirely to the use of steam hammers. Where there is a large amount of driving to do or especial need for fast work, a separate gang for framing is usually provided and some roads always provide them, but generally the same crew drives and frames a bridge.

The minimum depth of penetration for piles in trestles is usually considered to be about 15 ft. but there are numberless situations where piles stopped at this depth will not sustain the load. The determination of the proper stopping place is largely a matter of judgment and experience. Formulæ or rules have been devised to assist the judgment and a summary of the methods used by a number of railroad companies may be of interest.

Foreman's judgment without formulæ,	14 roads.
As long as the pile will drive without damage,	6 roads.
Practical refusal,	13 roads.
Engineering News formula,	4 roads.
Special instructions based on investigation and tests,	3 roads.

Central of Georgia:—3,000 lb. drop hammer with a 20 ft. drop, 1 in. penetration; Bucyrus No. 43, steam hammer, ¼ in. per blow.

Central of New Jersey:—3,000 lb. drop hammer with a 15 ft. drop, 1 in. penetration.

Chicago & Northwestern:—3,000 lb. drop hammer, 30 ft. drop, ½ in. penetration. (Above applies to foundation piles. Engineering News formula is also used.)

Illinois Central:—3,000 lb. drop hammer, 20 ft. drop, ½ in. penetration.

Michigan Central:—3,000 lb. drop hammer, 15 ft. drop, 2½ in. for last 5 blows.

New York Central Lines West:—3,200 lb. drop hammer, 30 ft. drop, ½ in. to 1 in. penetration.

N. Y. N. H. & H.:—2,000 lb. drop hammer, 25 ft. drop, 10 in. for last 10 blows.

Norfolk and Western:—The Engineering News formula is as follows:

Steam hammer $S = \frac{2\ W\ H}{P \text{ plus } .03}$

Drop hammer $S = \frac{2\ W\ H}{P \text{ plus } 1}$

S=safe load in tons. W=weight of ram in tons. H=fall in feet. P=penetration of last blow in inches.

Philadelphia & Reading:—2,250 lb. drop hammer, 15 ft. drop, refusal; 3,300 lb. drop hammer, 10 ft. drop, refusal.

St. Louis & San Francisco:—No. 2 Vulcan hammer, 1 in. in 4 to 6 blows.

Toledo, St. Louis & Western:—Penetration of 14 ft. to 16 ft. Conditions uniform.

Western Pacific:—Steam hammer, on new work, ¼ in. penetration, at last blow.

Records showing the total penetration are quite generally kept. Blank forms on which a variety of information is shown are used on many lines. A very complete form of report was submitted by the Southern Ry. but as another committee is to report on the subject of forms further consideration will not be given this matter here, except to call attention to the great importance of such records.

The committee was unfortunate in the wording of the question relating to the cost of driving. It was intended that the cost of the pile should not be included but this was not made clear. We have also been criticized for using the unit, "foot of pile below cutoff," and "foot of pile in the ground" has been suggested. The former unit is generally used and is applied to practically all contract work. The committee thought that it was following ordinary practice.

It is well known that unit cost figures have to be considered in connection with conditions that prevail where the work is done. The figures appended are intended to furnish, in a general way, the average cost on the lines mentioned.

The water jet is in successful use under proper conditions on about 50 per cent of the railroads reporting. Some use it only with concrete piles, others for foundation piles or with a marine driver only. But one failure is reported and that is ascribed to the small size of the pump. Favorable conditions for the use of the jet are sandy soil, or gravel, and deep penetration. The practice is fairly uniform. That of the New York Central (Lines West) is typical and is as follows:

"We sometimes use a water jet to drive piles in sand where it can be used advantageously without endangering the track, and where there is an abundant water supply and opportunity for the waste water to run away without causing trouble. For jetting, we use a pump of sufficient capacity, placed near a stream or other body of water when at hand, or else on the driver tank and pump from the tank to the jet. The object of the tank, which is kept filled from the nearest available supply, is to have an abundant quantity of water for quick use. We use a 2½-in. hose with a 2-in. iron pipe jet 30 to 40 ft. long, with the lower end drawn down to a diameter of about 1¼ in. to serve as a nozzle. The jet with the water running is lowered down into the ground, forcing the sand out as it goes down, to a depth which is sufficient to take the pile with just enough driving so it will stand solid after it is driven to place. For a 30-ft. pile we generally jet the hole so that the pile will go down about 25 ft. under the weight of the hammer and can then be driven about 5 ft. to place."

Jet pipes vary in size from 2½ to 1¼ in. and nozzles from no contraction on a 2-in. pipe to ½ in. at the end of a 1¼ in. pipe. The Chicago and Northwestern sends the following description of a jet pipe: "A 2-in. pipe drawn out to a 1-in. nozzle, and somewhat longer than the depth to be penetrated, is used. The upper end is fitted with an elbow, a nipple and a loose connection to a duplex pump of sufficient capacity to maintain a pressure of 100 lb. per sq. in. in the pipe with an unobstructed flow through the nozzle. A separate line tied to the top of the pipe passes over a block at the top of the leads and down to the winch-head and furnishes means for readily raising and lowering the pipe." On the Southern Pacific, the jet pipe is drawn out to a rectangular shape about ¼ in. by 2 or 2½ in. Some advantage is claimed for this shape when used in stiff material. Two jet pipes are occasionally used as it is somewhat easier to guide a pile to correct position in this manner. The water pressure used varies from 100 lb. to 225 lb. per sq. in. and pumps with 3 or 4 in. discharge pipes are generally used. A large volume of water at moderate pressure gives the best results. Prof. Jacoby, in his book referred to previously, states that from 50 gal. to 250 gal. of water is required per min. but other authorities place the quan-

tity at from 250 gal. to 500 gal. per min. A water jet may also be employed for loosening piles which are to be pulled.

A somewhat different type of jet wherein steam takes the place of water is in use on the Chicago, St. Paul, Minneapolis and Omaha Ry., and is described as follows: "We use a steam jet on a track driver when jetting is advisable and have found it practical and economical to bore the piles and insert the jet pipe so the full force of the jet is applied at the center of the point of the pile. A hole of proper size is bored in the center of the point and at an angle such that it comes out the side of the pile about two feet above the point. The nozzle of the jet is inserted in this hole and allowed to go down with the pile. This method has been used and found very satisfactory where it was desired to drive false work piles down to rock to support two heavy spans while piers were being rebuilt."

In view of the large amount of attention given to the matter of safety during the last few years, an effort has been made to bring out descriptions of features which have been adopted for this reason and a list is presented herewith which it is believed will prove interesting and profitable. Some of the suggestions have already been adopted by practically everybody.

Rail clamps when driving on the side.

Cable guards to protect leads when driving on high elevations.

Steel pile cap.

Steam power for operating leads and car brakes.

Driver so constructed that no idler car is required when in a train.

Covering for all moving parts of machinery.

Stops for holding the hammer while a pile is being set in place.

Cables run along the main tension braces on a land driver and fastened to the main members to prevent the collapse of the frame in case of bolt failures.

Hand railing around the driver and tank at about the floor level.

The steam hammer.

Careful design.

Competent men.

Careful inspection of lines and keeping the driver in good repair.

Provision for throwing the propelling mechanism in and out of gear from the side of the car.

Painting white the side of the hammer nearest the engineer so that he may readily see it.

The use of a blue lantern to signal the engineer when working at night to avoid confusion with train signals.

Special precautions to insure protection by flagmen as well as by train orders.

Metallic steam hose from the boiler to the hammer.

Foot boards on the front end.

Pile and hammer cables carried under the floor of the car; two extra running sheaves are required to accomplish this.

One or two other suggestions were made but were not described in sufficient detail.

Practically every one is interested in knowing how the other fellow meets unusual conditions or problems; or of any means he has adopted for saving time and money. A number of interesting examples have reached the committee and are presented as follows:

Canadian Northern:—On certain parts of our line deep muskegs are encountered, the grade line of the railway being but a few feet above the surface of the muskeg. Piles longer than the driver leads are often required in these places. Sometimes the piles are raised and dropped vertically, outside of the leads, several times until sufficient penetration is obtained to allow them to go under the hammer. At other times sufficient penetration can not be obtained in the above manner and it is then necessary to lash a tapering timber to the side of the pile. Light

blows of the hammer are applied to this timber until the pile will go under the hammer and regular driving can proceed. We have also encountered a deep and rather soft clay, too deep for the point of the pile to reach firm bottom even though splicing of piles may be resorted to. In such cases timbers are bolted on, giving a horizontal cross section of the pile resembling a Maltese cross. This enlarges the surface of the pile in contact with the clay and has given satisfactory results when used with discretion.

Chicago, Milwaukee & St. Paul:—On busy lines a very limited time is allowed drivers between trains. These troubles have, in certain cases, been remedied by the use of telephone communication between the pile driver and the train despatcher.

Chicago, St. Paul, Minneapolis & Omaha:—Where trestles are being re-driven, we make a practice of moving the piles to the driver with a team where ground conditions will permit, and by rafting them where we have open water. We have found this to be economical as it saves the expense and time of moving the work train back to the end of the trestle to pick up piles.

I am forwarding a photograph showing a self-propelled pile driver which was used for locomotive power on an abandoned line in connection with the removal of the bridges and track. Its use for this purpose for a period of two months proved very satisfactory and economical. The illustration may be of interest to many as it shows a unique method of falsework used in the vicinity of power dams on the Black river, Wisconsin. (See Fig. 9.)

Delaware, Lackawanna & Western:—Where pockets of gravel and strata of hard pan are encountered, we make it a rule to stop driving instead of driving through to softer material which a test may indicate is present.

Detroit & Mackinac:—In September, 1915, we renewed the piles and caps in a trestle, where the chord was practically new, by pulling the new bents to place after the old ones had been cut out, and without moving or cutting the chord.

Gulf, Colorado & Santa Fe:—On part of our southern division which is located in a semi-arid region in western Texas, we often encounter ground which is hard to drive through on account of the baking which it receives during long drouths. To meet this condition we have excavated for the piles holes about two feet deep, which are filled with water and allowed to stand over night. In this way the penetration required is more easily reached. In the same territory a chalky limestone is encountered in which driving is greatly aided by first springing with dynamite and then flooding the holes with water. After this is done we are able to secure penetration of 24 to 26 ft.

In the Engineering News for Sept. 16th, 1915, there is a description of the use of explosives for loosening the ground in advance of pile driving. The material encountered was compacted sand, clay and gravel, with boulders up to ten inches in diameter. The piles, which were of concrete, were intended to reach a depth of about 20 ft. and the charge was exploded at a depth of 18 ft. An 18-ft. length of 3-in. pipe, having a removable cap at the lower end and reinforced with a coupling at the top, was first driven. The charge, which consisted of Judson powder R. R. P. and was contained in a tin tube 2½ in. in diameter and 3 ft. long, was then lowered into the pipe and the latter withdrawn leaving the removable cap in the ground. Charges were exploded in three separate holes for each bent of five piles. The concrete piles were then driven with very satisfactory results as to grade, the bearing being much more than required.

Illinois Central:—At some points, we encounter hard pan and shale close to the surface, making it necessary to use cast points on hard wood piles to prevent brooming. We have had cases where false-work piles

without shoes were driven into shale and have found, when pulling them, that the bottoms were broomed 2 ft. or more.

A number of roads commend the use of pile shoes where the material encountered is shale, coal, or submerged timbers and logs.

Kansas City, Mexico and Orient:—It is our experience that in nearly all cases piles drive and carry their load better when not sharpened and especially so when the penetration is slight and the piles land on rock.

Long Island:—Density of traffic seriously interferes with all construction work. This is met by the temporary abandonment of tracks on four and six-track lines and by working at night on other congested lines.

New Orleans, Mobile and Chicago:—With the exception of foreman, assistant foreman and a friction man, we are now using negro labor in our pile driver gang. Thus our pile driving costs less than if white labor were used.

New York Central (Lines West):—We have sometimes had to drive piles for falsework which struck solid rock at an elevation above the bottom of the excavation. In these cases, the piles were generally pointed with large square points so they would stand firmly on the rock under traffic until they could be excavated and replaced with frame bents.

At other places where driving has been extremely soft and very long piles would be needed to give sufficient penetration to stand firmly under our loads, we have driven 40-ft. soft wood piles down to the rail, spliced 30 to 35-ft. oak piles on top of them, and continued driving, thus obtaining the equivalent of piles from 70 to 75 ft. long. One bridge driven entirely in this way has carried safely for 20 yrs. without further penetration or settlement of the piles under traffic.

Pennsylvania Lines West:—A considerable amount of the pile driving work on our divisions is the driving of piles for temporary structures to support the track while permanent work is being installed. In supporting the tracks in case of emergency, such as floods, washouts, etc., we have many occasions for driving piles under trusses to support panel points on account of a weak structure and on account of undermining or failure of masonry. The most satisfactory machine for such work is a derrick or locomotive crane with suspended leads and a steam hammer. Such a machine is capable of driving the ordinary pile trestle with about the same rapidity as the regular pile driving machine.

Philadelphia & Reading:—With frequent train movements on high fills, platforms are built on each side for the driver. As time permits the machine is run over the track, the pile driven, and the track cleared for train movements. This is successful when the average time between trains is 15 min.

The Chesapeake and Ohio Ry. and the Western Maryland report piles driven by contract except in emergency cases. This, of course, is common practice in the case of foundation piles but is somewhat unusual for trestle renewals.

Maro Johnson,
J. P. Canty,
R. H. Reid,
J. P. Wood,
O. F. Dalstrom,

Committee.

Average Cost of Driving Piles.*

Road	In Foundations.	In Trestles.	With Marine Driver	
Boston & Albany,		$.29 to .35		Includes matl.
Boston & Maine,		4.06 to 7.10		Per pile
Can. Northern,		.08 to .15		Work train not incl.
Cent. of Georgia,		.06 to .10		
Chicago & N.-W.,	$.25 to .40	.15 to .20		Includes matl.
" " "	.15 to .20			Inc. matl. Steam Hammer
C. St. P. M. & O.,	.14	.17		
C. C. C. & St. L.	.35 to .60	.25 to .35		Includes matl
Del. L. & W.,		.20 to .25	$.25 to .30	" "
Denver & R. G.,		.28		" "
Det. & Mackinac,		.18	.06	
Dul. M. & N.,		.07	.04	
E. P. & S. W.,		.12		
Gulf C. & S. F.,		.13½		
Illinois Central,		.08		
Int. & Great Nor.,		.12½		
Kan. City Sou.,	?	.15	.10	
Lake Erie & W.,		.15		
Mich. Central,		.07 to .09		
Mo. Kan. & Tex.,		.08 to .12		
N. O. M. & K. C.,		2.50		Per pile
N. Y. C. Lines W.,		.05 to .40		
Pennsylvania Lines	.20 to .30	.40 to .60		Includes matl. .35 to .40 without material.
Phila. & Reading,		.32	.20	Inc. matl.
Queen & Crescent,		.14		
S. A. & A. P.		.20 to .26		
Seaboard A. L.,		.04½	06	
St. L. & San F.,		.09 to .10		
St. L. S.-W.,		.07		
Western Pac.,		.09½		Without work train.
Wheeling & L. E.,		.10 to .25		

*Note:- Unless otherwise stated-figures are for driving only.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

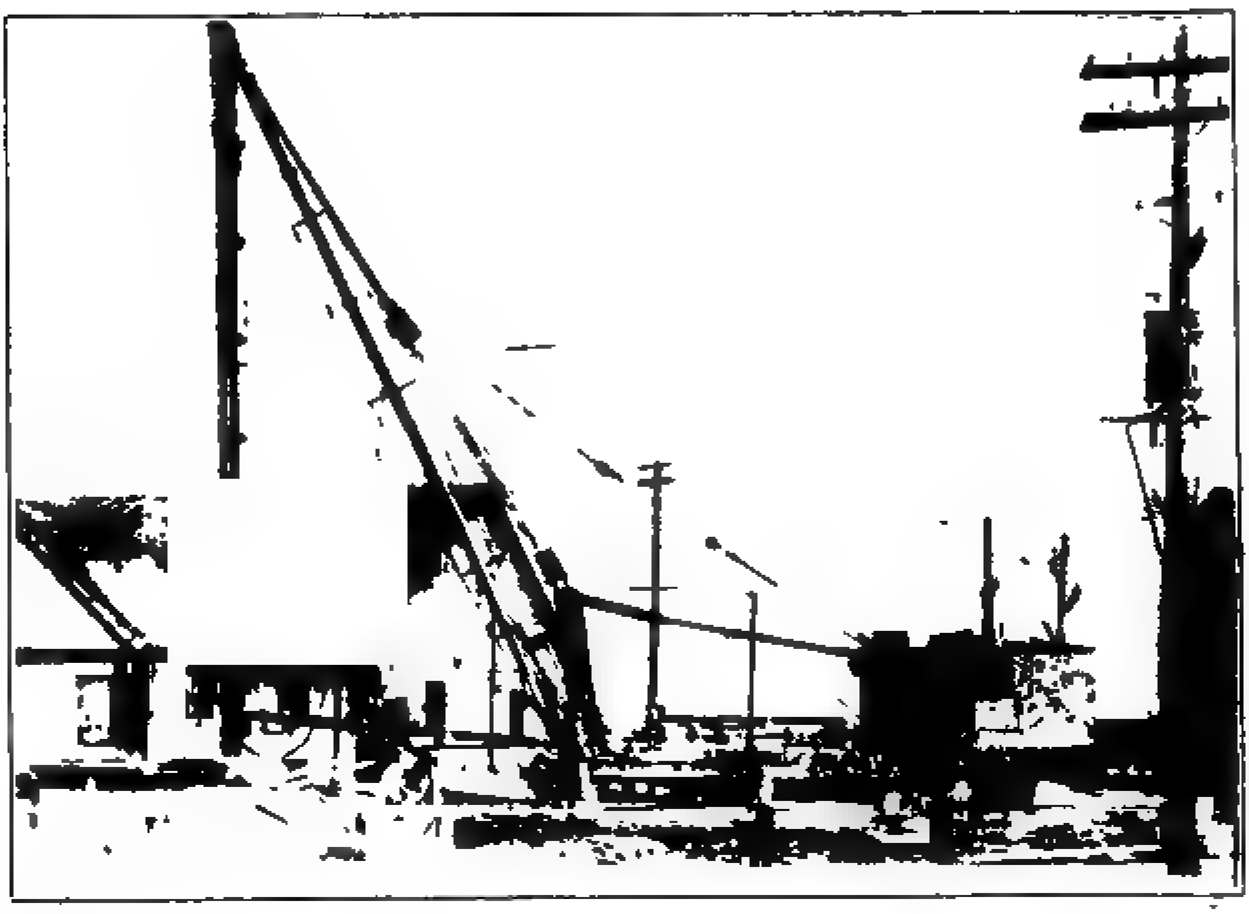


Fig. 7

Fig. 8

Fig. 9

Fig. 10.—Pile-driver with single acting steam hammer on the Chicago & Eastern Illinois raising and driving 75-ft. treated piles in 44 ft. of water, 65 ft. from base of rail to bottom of stream, current 5 miles per hour

DISCUSSION.

(Subject No. 6—Modern Methods of Driving Piles)

The President:—This report ought to bring out considerable discussion and comment. I will ask all those speaking to be as brief as possible. There are one or two points that might be brought out that were not mentioned in the report. One of these is a comparison between the single and double-acting steam hammers; another point that I wish the report could have brought out, is reference to the experience with steam hose or steam hammers.

A. S. Markley:—The Chicago & Eastern Illinois bought a single-acting steam hammer from the Industrial works, Bay City, Mich., in 1902. The weight of the hammer was 2,700 lb., while the combined weight of the cage and hammer was 4,790 lb., the stroke was 2 ft. 8 in., and the length of the hammer over all, 10 ft. 8½ in. We tested this in comparison with a drop hammer weighing 2,800 lb., with a 37-ft. drop, hoisted with a ⅝-in. steel cable and reeling from a friction drum. In making the test we first drove the pile with the drop hammer to what appeared to be a solid foundation. We then applied the steam hammer and doubled the penetration. This steam hammer is still in service. I am convinced that there is no advantage in using a double-acting steam hammer as the punishment inflicted on the pile is liable to be too great.

We have driven all the piles on all divisions with this single-acting hammer since 1902 with a penetration of 35 to 40 ft. without a single failure. We use oak, pine and cypress piles, treated and untreated.

The steam hammer dispenses with the use of taugles and bands on the heads of piles. Even the use of cast or wrought follower caps are not necessary. Bands would break, taugles would fall out and follower caps could be used only to the bottom of the leads, while with the steam hammer a pile can be driven 7 ft. below the leads.

At times of washouts and for temporary work we drive piles to the required depth to save sawing them off to receive the caps. I estimate that, taking everything into consideration, the cost of driving with a single-acting steam hammer is from 15 to 25 per cent less than when driving with a drop hammer. With a drop hammer the load has to be pulled to the top of the leaders at every stroke of the hammer while with a steam hammer the load is pulled to the top only when beginning the driving of each pile; use of the steam ham-

mer reduces the wear of the cable and also the wear and tear of the hoisting machinery.

Fifty ft. of steam hose costing $1.30 per lin. ft. is required to operate a steam hammer which, on a basis of 38,000 lin. ft. of piling driven with each hose, costs $1.71 per 1,000 ft. of piling driven.

With our steam hammer at the top of the 40-ft. leads we have raised and placed 75-ft. piles in the leads without upsetting or damaging the driver. We delegate one man to stay with the driver who, with a careful engineer, gives the hose the proper care and attention. By so doing we experience no damage to it.

J. P. Wood:—We use a drop hammer with a follower cap and do not experience any trouble with the brooming of the piles by this method. We use a gage to head the pile so that the head is small enough to fit inside the follower and leave ample room for play.

The President:—Does not the wood cushion block in the top of the follower cap wear out pretty rapidly?

J. P. Wood:—No sir; we make the blocks out of a good quality of white oak and they last a long time.

The President:—A year or so ago we drove a bent of piles to a uniform depth with a drop hammer, the final penetration being a quarter of an inch per blow. When we excavated for a pier foundation we found one pile was on the flat surface of a concrete pier that had overturned and this pile had been broomed for 10 ft. or more. There was no indication of brooming that could be noticed while driving. I am satisfied that 50 per cent of our piles are over-driven. I am of the opinion that a steam hammer will drive a pile all that it will stand. I would like to ask if that opinion is shared by anyone else in the room?

(Several members answered in the affirmative.)

The President:—I make those remarks after considerable investigation and study of the subject. I would like to get the opinions of several members who have had experience with both single acting and double acting steam hammers.

L. D. Hadwen:—There is a disadvantage with the single-acting hammer in the longer leads required. The double-acting hammer is more comparable in the length of the leads it takes up. I think the double acting hammer is often commented on unfavorably in that it is compared with the single-acting hammer. Our experience has been that we are apt to get too light double-acting hammers; more especially for foundation work.

R. H. Reid:—We have both kinds of hammers and do not think

there is much difference in their operation. Both do good work, and I believe they will drive piles equally well. The double-acting hammer strikes more rapidly but delivers a lighter blow.

• Referring to the relative merits of the drop hammer and the steam hammer: on most work the steam hammer will do any work that the drop hammer will do. A steam hammer costs more than a drop hammer; it is heavier and is not so easily handled. It is more liable to tip the machine over if the track is not level, and there is a greater possibility of the steam hammer getting out of order. The steam hammer is easier on the leads. An outfit will last longer with the steam hammer and it will drive piles faster. For ordinary locomotive driver work I think the steam hammer will work faster and perhaps more economically than a drop hammer, taking everything into account.

The President:—Do you not believe that the greatest objection to the steam hammer is its length?

R. H. Reid:—That is the main objection. A No. 2 Vulcan hammer is about 11 ft. long, while an ordinary drop hammer is about 42 in. long.

W. E. Alexander:—We have never used a steam hammer on our road, but I have seen them used in different localities. At one place where soundings had been made to determine the length of piles necessary an attempt was made to drive the piles with a steam hammer but they could not be driven to within 8 or 9 ft. of the required depth. A drop hammer was substituted and the piles were driven to the depth indicated by the soundings.

The Secretary:—It would seem that, if the piles were driven as far as they could be driven with a steam hammer, it would scarcely be necessary to try to drive them farther.

The President:—There must be some point where the weight of the hammer and the rapidity of the blow must come to what one might call a balance, or dividing line. It is understood, of course, that it requires a great amount of energy to overcome the resistance of the pile to move, and that if one hits the pile with a light hammer with sufficient speed he may deliver as many foot pounds on the head of the pile as with a much heavier hammer moving at a slower speed. Naturally one would think that if the number of foot pounds on the head of the hammer were the same, the result ought to be the same. We might imagine to carry this idea to an absurdity, getting above the pile with a machine gun and driving bullets against it with enough speed to get the same number of foot pounds per minute as

with a steam hammer. The double-hammer maker compares the speed of the blow and the weight of the hammer with that of a larger and heavier hammer moving at slower speed.

No doubt every one has had a great deal of trouble with steam hose on pile hammers. There is no use saying that any particular brand is a good hose. The only thing to do is to prepare a specification for steam hose, give it to the purchasing agent and let him buy the hose to that specification. We have been trying to get up a specification, and the feature that seems to be the most pertinent is to say that the steam hose must be manufactured especially for steam pile driver purposes. Then you can go ahead with as much a specification as you are able to get together. That brings it down to competition among people who manufacture steam pile driver hose, and excludes the garden hose man.

A. S. Markley:—I do not agree with the president. The railroad companies should not prepare specifications for steam hose. The manufacturers have chemists that are experimenting all the time with their products and are more capable than the railroads of designating the best hose. If a manufacturer furnishes poor hose, he probably does not do so more than once with the same road, if the company keeps a record, which no doubt all do. If the railroads furnished specifications they would be required to see that their specifications were adhered to, and be responsible for the outcome. On the other hand all the responsibility is placed on the manufacturer who will be careful to maintain a good reputation in order to sell his goods, by using the best materials.

A. Montzheimer:—If we are through on the hose question I want to mention a matter in regard to the record of piles driven, shown on page 146 of the report. I think it is very important, now that the valuation work is going on, that a good record be prepared of piles driven. Parties go out, to get the length of piles in bridges, and they have no means of knowing their penetration. If the railroad can show the length of the piles used in a bridge it is a big advantage, and furthermore it is a big advantage to show the original length of the pile and the percentage of waste, because it is a mooted question how much should be allowed for wastage on piles and how much should be allowed for piles destroyed or damaged. Records of that kind will be very valuable in valuation work.

The President:—I believe the present system of accounting calls for all of that, does it not?

A. Montzheimer:—The trouble is that so many bridges are driv-

en in which the records show the lineal feet of piling charged to the bridge. If it is a renewal job, this is an operating expense, and it might be difficult to locate the exact charge to a particular bridge.

The President:—I think it is clearly understood that it costs about so much to drive a pile regardless of its length, on maintenance work. Is that not so?

B. F. Pickering:—There is a wide variation. I have one bridge where the piles are 90 ft. long and cost about $125 each in position.

J. P. Wood:—We can show from our records the cost of piles and the cost of driving them on each job, together with details, such as the penetration, number of blows, etc.

A. S. Markley:—Our inspection books and records on all bridges have been kept complete since 1881. These records are invaluable for the valuation department.

L. D. Hadwen:—I believe the committee did not consider the relative values of wire cable and Manila rope. It seems to me that this is quite an important item. It is becoming more and more the practice to use steel cables for hammer lines where drop hammers are being used. We use the steel cables on our drivers.

The President:—Does anyone have any objection to using steel cables for pile driving purposes?

E. K. Barrett:—We have driven as many as 1,300 35-ft. piles with a ¾-in. soft wire cable.

W. E. Alexander:—We use a drop hammer weighing something over 4,700 lb. We also have a lighter hammer. When we began using the large driver it was furnished with Manila rope for both hammer and pile lines, but the hammer line wore out so rapidly that we substituted a ⅝-in. wire cable. Some objected to the cable but I had used it before and knew that it would be a success. It has given good satisfaction. The only place it causes trouble is where it is attached to the hammer. The clips have to be replaced occasionally. We use 1½-in. Manila rope for the pile line with a piece of chain at the end long enough to go around the pile.

The President:—What is the objection to using a wire cable for a pile line?

W. E. Alexander:—I know of no objection. I think the cable would answer the purpose, but we find that the rope lasts a long time, hence we continue to use it.

The President:—It is a fact that the wire cable costs less than the rope. On some jobs a rope will last one day while a wire cable

will last a year. I would like to ask if anyone here has any objection to the use of wire cable for both hammer and pile lines?

R. H. Reid:—We use both, Manila rope and wire cables, for hammer lines as well as for pile lines. I am unable to say what the difference is in cost, but I find that the wire cable wears out more rapidly than the Manila rope. It also wears out the sheaves more rapidly. Manila rope is more flexible and more easily handled in leading out after piles, and I think that in a general way the men prefer it.

A. S. Markley:—We use 5/8-in. wire cable for both pile and hammer lines, with a 5/8-in. slip hook on the end of the pile line which will outlast 4 or 5 rope iines and give better results.

B. F. Pickering:—We find very little difference between the life of Manila rope and wire cables along the coast for pile driving purposes. Instead of the ordinary Manila rope we use a 4-strand lubricated rope. That will last fully as long, I think, as the wire cable that we use. There is but little difference in their cost. I have one driver equipped with rope and one with wire cable.

SUBJECT No. 8.

EFFICIENT METHODS OF HANDLING WORK AND MEN.

REPORT OF COMMITTEE.

We are sometimes apt to wonder if the words "efficient" and "efficiency" have not been overworked, but when we cast about for synonyms we find that they will not do, and so we use these words over and over again, and with added use they gain added force. Let us examine their definitions—

Efficient—Causing effects; producing results; actively operative; not inactive, slack or incapable; characterized by energetic and useful activity.

Efficiency—The power of producing the effect intended.

These are all forceful words and expressions that come at one like the blows of a triphammer, and in themselves make one want to do things efficiently.

Nowhere is efficiency more necessary than in railroad construction or maintenance work, and it is a subject that is of vital interest to the man in the field. There may be extreme emergencies in which work must be done regardless of cost and where the results justify the expense, but such cases are the exception. As a rule the work that is efficiently done is the most economical, is a better looking job and is a source of satisfaction to all who took part.

The subject assigned to this committee opens up a new field for committee work. In 1915 G. W. Rear presented a live and forceful paper on "Efficiency" which makes a splendid introduction to the present report which consists of a series of brief sketches showing how work has been handled in specific cases. This is a good method of recording valuable information that might not readily fit into some committee report. With this brief introduction the committee presents herewith a number of brief articles furnished by members of the association.

F. E. Weise,
E. R. Wenner,
S. C. Tanner,
J. F. Pinson,
Committee.

Paving a Track Laid in Center of Street With Concrete.

By S. C. Tanner, Baltimore & Ohio R. R.

During 1915 the Baltimore & Ohio was called upon to pave its track in the center of Pratt street, Baltimore, Md., a strip 9 ft. wide and about one-half mile long. Local conditions made it necessary to maintain street traffic on each side of the track without interruption, and, therefore, all equipment and material had to be handled from the track which is in the center of the street. The track in question is used only between the hours of 9 P. M. and 5 A. M., for handling cars to and from private sidings, and thus the work could be carried on in the daytime without being interrupted by railroad traffic. After the excavating had been

done, concrete was placed under the ties to a depth of 6 inches. After it had set sufficiently the track was resurfaced and poured with more concrete to within 5 in. of the top of the girder rail, 930 cu. yds. of concrete being placed.

The following force was employed on this work:

One mason foreman	40.8	cents per hour
One mason foreman	33.5	" " "
Four mason helpers	23.0	" " "
Two mason helpers	20.0	" " "
Twelve mason helpers	17.0	" " "

The equipment used on the work consisted of one ½-yd. concrete mixer placed on the end of a flat car in such a manner that it would discharge over the end of the car into a trough leading to a drop-bottom dump car, one hoisting engine and 36-in. boiler to furnish steam for the engine and concrete mixer. The hoisting engine was used to pull cars back as fast as the street was concreted. Space was provided on the equipment car for cement. Back of the equipment car were three cars of crushed stone followed by two cars of sand. A double runway was placed on top of the gondolas for wheeling stone and sand to the mixer, thus putting the concrete in place by one handling of material.

The accompanying photograph shows the equipment in operation on the corner of Pratt and Eutaw streets.

Following is a detailed statement of the cost of this work:

		Per Cu. Yd. of concrete	Total cost	Cu. Yd.	Total
930 cu. yd. crushed stone	$ .75	$ .75	$ 697.50		
613 cu. yd. sand	.56	.37	343.28		
953 bbl. Portland cement	1.13	1.15	1,076.89		
Gross total material		$2.27	$2,117.67		
Credit on 3,812 empty sacks cement, @ 7½ cents		.30	285.90		
Net total cost of material		$1.98	$1,831.77	$1.98	$1,831.77
Labor hauling, mixing and spreading concrete		1.12	1,040.30		
Hauling cement by team and truck ¾ mile		.21	197.50		
Total labor		$1.33	$1,237.80	1.33	1,237.80
Freight rate on Co. material		.47	439.54	.47	439.54
Grand total				$3.78	$3,509.11

Paving a Track Laid in Pratt St., Baltimore, Md., B. & O. R. R.

Removing Ties On a Long Girder Bridge.

By E. R. Wenner, Lehigh Valley R. R.

At Towanda, Pa., the Lehigh Valley has a double track deck plate girder bridge, 1,808 ft. long, consisting of 13 spans, with a maximum height of 45 ft. from the base of rail to the bottom of the stream. The east bound track, known as track No. 1, has 1,532 8 in. by 12 in. by 12 ft. creosoted ties, some with an elevation of as much as five inches, as the bridge is on a curve. The renewal of these ties was handled in the following manner:

All of the ties were framed at the site of the bridge which is located in the yard at headquarters. Slots were cut across the framed spots to allow for rivet heads in order that no framing of any kind need be done while the ties were being placed except for some rivet heads on gusset plates. As they were framed the ties were placed in piles of two tiers each and seven ties high, in numerical order, in such a way that when the ties were thrown over, one to the left and another to the right, they would fall in proper order ready for placing. The ties were loaded on cars with a locomotive crane by placing a chain around each pile as it was loaded and they were unloaded on the bridge in the same manner, handling the piles in proper order.

On the day before the ties were to be placed, all wooden guard stringers and clip bolts were removed from the bridge, and the tops of the girders between the ties were cleaned and painted. On the day the

ties were placed, the trains were operated over a single track, using a motor car with a train crew to pilot them. The work was done with 3 locomotive cranes with operators, 1 engine and crew, 2 general foremen, 2 carpenter foremen, 24 carpenters, 1 painter foreman, 20 painters, 1 general track foreman, 3 track foremen, 80 track men, 1 signal man and 1 pilot crew.

The track was opened at 6 A. M. and one locomotive crane with half of the men started at each end of the bridge taking out the old ties and placing new ones. Each locomotive crane had behind it a car of new ties ready to place. Fourteen old ties were bunched up and lifted from the bridge at each operation and loaded on cars on the opposite track which were handled by the engine and the third locomotive crane between trains. As the old ties were lifted out, the painters cleaned and painted the tops of the girders, after which a pile of 14 new ties was lifted from the car behind the crane and put in place. This operation was repeated by the crews at both ends of the bridge until all of the 1,532 new ties were placed, the track laid, the ties plated and full spiked and the iron guard rail placed. The time consumed for this work was 12 hours. The ties and elevation blocks contained 160,012 ft. B. M. of timber.

The above method of handling the work was considered a great improvement over the old method of placing ties without the use of locomotive cranes. It effected a great saving in expense and reduced the annoyance of interference with traffic to a minimum. The men were so placed for this work that each man had his particular duty to perform and all operations had been carefully planned out in advance. Everything was carried out as planned in a very satisfactory manner. The two pictures accompanying this article show clearly how the work was handled.

Since the above work was done, the Lehigh Valley has used the same method of renewing ties on several other bridges with equally satisfactory results. One was the renewal of ties on Bridge No. 206 at Tunkhannock, Pa., a double track through girder bridge having 560 8 in. by 9 in. by 10 ft. ties, on both tracks. These ties were all renewed, the track replaced, the ties plated and full spiked and the iron guard rail placed in one day, between trains, and this without abandoning either track and passing 44 trains. This would have been impossible without the use of locomotive cranes.

Renewing Bridge Ties with Locomotive Cranes, L. V. R. R.

Placing New Ties with a Locomotive Crane, L. V R. R.

Placing Girder Spans Without Falsework.

By G. W. Rear, Southern Pacific Co.

On an extension of a railroad having no suitable derrick car for handling girder spans, a car was rigged up from parts of a truss bridge that was to be erected later on. The accompanying illustration shows the car plainly. It will be noted that the boom is the lower chord of a truss span and extends nearly to the rear of the car. The back stay is a plumb or vertical post and the forward stay is built of counters. The A-bent was built of timbers and of a suitable height. Power was taken

Placing Girder Spans with a Home-Made Erection Car, Sou. Pac. Co.

from an accompanying locomotive crane which also propelled the car on which the derrick was mounted. The car and derrick were counter-weighted with rails. All of the girder spans on the line were set with this device without the use of falsework. In the illustration the car is shown as handling a 60-ft. span. The cost of rigging up and dismantling the car was $66, a very small item of expense as compared with the cost of falsework which was saved.

The car was built by the late F. S. Edinger, a member of the American Railway Bridge and Building Association, and greatly reduced the cost of girder erection.

Replacing Truss Spans With Girder Spans.

By J. P. Wood, Pere Marquette R. R.

The Pere Marquette found that its bridge over the Grand River at Ionia, Michigan, consisting of four 140-ft. through steel truss spans on a skew which was built in the days of 34-ft. box cars and small engines, was inadequate to meet the demands of modern equipment, both as to clearances and loadings. It became necessary to replace it with a heavier structure, and a bridge consisting of eight 70-ft. deck plate girder spans was decided upon, the grade being raised sufficiently to give the same height for waterway.

After building the necessary additional piers, the truss spans were jacked up and cribbing placed at the same time that the filling was being done. After this the old floor beams were cut out and the girder spans placed in the usual manner, the trusses remaining on the cribbing.

When ready to move, the trusses were jacked high enough to clear all obstructions and loaded on two gondola cars as shown in the accompanying illustrations, after which they were hauled out to solid ground where they could be dismantled readily.

In order to load the trusses securely, four 6 in. by 8 in. wooden posts and two I-beams were used with each gondola. The posts were bolted to the end vertical posts, one on either side, and cut at a length that would carry the truss clear of all obstructions as the lower ends rested on the I-beams which in turn rested on top of the car. The I-beams were bolted together at the ends and on each side of the posts to keep them from rolling or canting with the sway of the truss as it was being moved. Two guy lines were also used, one at each end, one end of the line being fastened to the top of the truss, and the other end to the car. Because the old bridge was to be scrapped, each truss was taken to the same place to be dismantled, thereby bringing all of the same members together and saving time and expense in shipping.

No work train service was required because the derrick car was self-propelling and had no trouble in handling the equipment and the gondolas loaded with the old trusses. The nearest siding to which it was necessary to go to clear for trains was 1,650 ft. away.

After the truss was jacked up, the longest time required for loading, hauling to solid ground and lowering any one of the four trusses to the ground was two hours. The last truss moved required six minutes after it was loaded to move it to the place where it was to be set on the ground. The force employed consisted of a foreman, an assistant foreman, and a crew of from 8 to 10 men, working 10 hours per day at wages ranging from $2 to $3 per day.

This bridge is on a single track line and 12 or more trains are scheduled during the ten hour working day. The work was completed without a moment's delay to any train. The equipment used consisted of the usual bridge tools, a concrete mixer and a derrick car with clam

shell bucket to lift the gravel to the mixer. By handling the work in the manner described above, it was unnecessary to build falsework and the results indicate that the work was done economically and that the saving amounted to practically the cost of falsework.

Replacing Trusses with Girders, Pere Marquette R R.

Construction of Two Concrete Bridges at Rosalia, Washington.

By J. F. Pinson, Chicago, Milwaukee & St. Paul Ry.

In 1915 the Chicago, Milwaukee & St Paul completed two single-track reinforced concrete arch viaducts on its Puget Sound line near Rosalia, Washington. These bridges replaced a frame trestle 60 ft. high and about 2,100 ft. long which was built in 1907 The line is on a 3 deg. curve to the left, and crosses successively the Palouse line of the Northern Pacific, a private road, Pine creek, a state highway, the

tracks of the Spokane and Inland Empire electric railway, and another private road. The distance between the two railway crossings is about 850 ft. At the time the construction of the concrete structures was begun there were two timber trestles with an embankment 334 ft. long between, the filling having been completed in 1911 before any definite

ELEVATION

The Concreting Plant

Fig. 1. Concrete Bridges, Rosalia, Wash. Chicago, Milwaukee & St. Paul Ry.

design had been decided upon for the permanent structure. The easterly structure consists of a 107 ft. 6 in. reinforced concrete trestle abutment, an 100 ft. spandrel arch span and a 79 ft. 6 in. reinforced concrete trestle abutment. The westerly structure consists of a 77 ft. reinforced concrete abutment, three 77 ft. 6 in. and one 68 ft. 4 in. rein-

forced spandrel arches, one 58 ft. 6 in. encased steel girder and a combination trestle and U abutment. The high fill east of and between the two bridges, and a side hill cut at the west end made it impracticable to place the plant on the track grade. After considerable study it was decided to locate the plant under the westerly bridge and this was done as shown in the diagram, Fig. 1. The crushed rock and sand were delivered in hopper bottom cars and unloaded through chutes to the ground below, and then handled to storage piles by a stiff-leg derrick with orange-peel bucket located so as to handle this material to the storage piles and from the storage pile to hoppers for loading the small cars, in which it was hauled to the mixer. The mixer and tower were placed on a traveling platform that could be moved along the north side of the bridge. In this way most of the concrete for the westerly bridge was spouted directly into the forms. One hoisting engine on this traveling platform did the hoisting of the concrete and also hauled the cars containing the dry material from the loading hoppers. The empty cars were hauled back to the loading hoppers by a counterweight fas-

Fig. 2.

tened to the bridge as shown in Fig. 1. The cement was unloaded into a storage house immediately underneath and south of the bridge by means of an endless belt with a friction brake which enabled the lowering of the cement at slow speed to prevent damage to sacks by tearing or burning. The cement was then wheeled directly to the cars as they left the loading hoppers.

The concrete for the easterly bridge was mixed by this same plant and hoisted into small cars on a narrow gage track on the north side of the main line and hauled by a gasoline locomotive. Concrete was mixed and placed in the easterly bridge for as low as 34 cts. per cu. yd. in this way, although the average was considerably above this on account of the inability to make continuous runs while concreting.

The steel reinforcement was all cut and bent on the platform at the west end of the westerly bridge and lowered into place from the track level. Portable forms were also built at the same point and handled in necessity of installing a pump was avoided.

The excavation for foundations for the piers caused very little difficulty, rock being encountered at from 4 to 10 ft. below the creek bed. The excavations for columns in the abutments, however, were more difficult, particularly for those coming high up in the fill, six of which required excavations to be made through the fill to a depth of approximately 60 ft. These were made by sinking a shaft and timbering with second hand 8 x 8 bridge ties. The material was hoisted by means of buckets. Water was encountered in the bottom of these foundations and was taken care of by driving a 2 in pipe through the fill into a shaft near the bottom and installing 2 in. Pemberthy ejectors No attempt was made to remove the cribbing or forms from the columns in these shafts below the top of the fill.

Fig. 3.—Concrete Bridges, Rosalia, Wash. C. M. & St. P. Ry.

The organization of the forces was as follows:

One general foreman	$150.00	per mo.
One timekeeper	75.00	" "
One carpenter foreman	3.50	per 10 hrs.
One blacksmith	3.25	" 10 "
One labor foreman	3.00	" 10 "
Two sub-foremen	3.25	" 10 "
Twenty-six carpenters	3.00	" 10 "
Two engineers	3.00	" 10 "
One engineer (gasoline)	2.50	" 10 "
One fireman	2.50	" 10 "
Ten carpenter helpers	2.25	" 10 "
Twenty-four laborers	2.00	" 10 "

The size of the crew varied considerably on account of the difficulty in obtaining men and on account of some delay in obtaining material and plans at various times.

During the progress of the work the average traffic was eight passenger and about twelve freight trains per 24 hrs. There was

an average of four passenger and four freight trains on the Northern Pacific track under the easterly bridge; eight passenger and four freight trains on the Spokane & Inland Empire tracks under the westerly bridge and heavy team and automobile travel on the state highway, so that it was necessary to provide special falsework in each case to avoid blocking traffic.

At the time of filling the easterly and center portions of the bridge in 1911 the bents in the trestle were crowded badly out of position; some of the bents being as much as 24 in. out of plumb. This made necessary the placing of heavy struts and shores, and in order to avoid disturbing the old bents as much as possible a special plan of supports for arch forms was devised as shown in Fig. 2. This was constructed so as to be entirely free and independent of the old bents and proved very economical as second hand timber was largely used.

The derrick used for handling the crushed rock and sand was of the ordinary stiff-leg type fitted with a 60 ft. boom and orange peel bucket. The engine used to operate the derrick was a double drum engine fitted with a Dake swinging gear connected to a bullwheel on the base of the mast for swinging the derrick. Attention is called to the construction of the tower on the traveler, enabling the moving of the tower along the bridge and the use of the counterweight for hauling back the empty material cars; also the method employed to avoid damage to cement sacks while unloading.

Fig. 4.—General View of Two Concrete Bridges, Rosalia, Wash., C. M. & St. P. Ry.

DISCUSSION.

(Subject No. 8, Efficient Methods of Handling Work and Men)

Mr. Weise:—We have not received as many articles as we hoped for. We trust that members will send in a number of such articles during the next year.

The President:—I would like to add to what Mr. Weise has said. It seems almost impossible to get this information from the members for everyone seems a little bashful about sending it in. Now that we have a start I hope to see more such information coming in during the next year. It is our understanding that the subject is to be continued, and it is hoped that the excellent start made this year will be an incentive to enlarge on the work. I hardly think that there is any necessity for discussion on this report. (No discussion.)

SUBJECT No. 9.

STATION BUILDINGS FOR PASSENGER SERVICE ONLY.*

REPORT OF COMMITTEE.

The railroad station is the modern gateway to our towns and cities and the residents are vitally interested in its design and arrangement because of the impressions made not only on the visitors but also on the traveling public. Many places are so located that the railroad station is the most important structure that can be seen from the train. We all know the value of first impressions. Railway companies fully realize this and are meeting the situation by replacing worn out, inadequate or obsolete station buildings with new, well designed, permanent structures as rapidly as is warranted.

Every architect has his own ideas as to design and arrangement but there are certain principles that apply to almost every station. Rural stations as a rule are not for display and therefore elaborate ornamentation should be avoided. Their chief purpose is to provide comfortable and pleasant shelters for passengers while waiting for trains.

Stations should be designed with simple, wide overhang and with broad platforms, preferably on all sides of the structure. Attention should be given to the driveway approaches and paths, and, where there is sufficient ground, shrubbery should be planted. Shrubbery should be selected that will be effective, not only through the growing season but through the winter months as well.

Unsightly objects that offend in the neighborhood of a railway may be hidden by trees, and banks may be covered with shrubbery or grass. Retaining walls can be adorned with climbing plants or vines. In suburbs, where the property is too valuable to allow shrubbery, color schemes, worked out in the building proper, are very effective.

There is no set rule by which the size of a station suitable for any town or city may be determined. The revenue from ticket sales is an index of the passenger business originating at a station, but it might be misleading as to the kind of a station required, for some towns originate very little passenger business and yet are called upon to handle heavy traffic. The amount of transfer business must also be considered and, where much of it is done, comfortable and commodious quarters must be provided. A careful study should be made of each city before definitely determining the size and character of the station required. Where no special conditions apply, a simple rule is to build a station to cost an amount in dollars equal to the population.

Many railroads have standard designs for their smaller stations but they cannot adhere to them very closely because every location has different conditions that require necessary modifications. As towns grow and business increases it is necessary to depart from the standards and make plans to suit the particular needs of each.

The station proper should have a general waiting room, and leading off from this, a women's retiring room, with toilet, and also a men's smoking room and toilet. On the opposite side of the room there should

* Considering stations only of moderate size, $25,000 and under.

be a ticket and telegraph office, and a baggage and express room. In addition to the ticket window there should be a window between the general waiting room and the baggage room so that passengers can check baggage without going out of the station.

Fig. 1 is the suggestion of the committee for the proportionate size and arrangement of rooms. (See p. 192.)

One of the main features to be kept in mind in designing a railroad station is the maintenance cost, and with this in mind the committee recommends the use of brick, stucco or concrete, because the first cost is very little higher than that of a frame structure. At some points stone costs about the same as brick. It makes a very good building material and gives a neat appearance. If brick is used it should be re-pressed or vitrified because a soft brick will result in a damp building. Rough texture bricks are being used extensively, and are more pleasing in appearance than smooth brick. In the matter of maintenance the painting of wooden buildings amounts to considerable. This is eliminated with brick, stone and concrete structures.

The roofs of stations require careful consideration. The plainer the roof lines are the cheaper is the upkeep, but appearance should not be sacrificed altogether for this item. The better buildings are roofed with tile or slate, and these materials should be used for slopes of 6 in. per ft. or over. There is a great difference in the quality of the grades of slate and tile, and care should be exercised in securing the proper grades of materials. The best grade of slate is considered expensive, but for length of service it exceeds that of any other roofing material. Because some roads have had unsatisfactory experiences with a poor quality of slate, some architects condemn all slate, which is a mistake. The difference in price between a good and a poor quality of slate is not very great.

There are a number of companies manufacturing roofing tile, and several companies are willing to place tile on a roof under a guarantee. While tile costs more than slate, the color adds a great deal to the appearance of the building. Ordinary sheathing paper is satisfactory under a slate roof, but a layer of composition roofing should be used under a tile roof.

Composition roofs, asbestos shingles and tin are used to a limited extent, but they are not recommended for the better class of structures

A great many types of gutters are used. Some architects advocate a standing gutter and others a hanging gutter, the latter being easier to repair. Hanging gutters of metal should be made of copper or of one of the pure irons, because ordinary galvanized iron will not last long. Fir lumber is used by a number of roads.

The interior of the station is usually of wood frame because it is cheaper and there is little danger of fire in a structure of this character Brick or hollow tile makes a more substantial and fireproof interior, but the cost is not often justified.

Walls are generally plastered and usually the lower five or six feet are covered with a wood wainscot in the waiting rooms, with tile in the toilet rooms. In many stations the walls are finished with a light colored brick. This gives a finished surface that lightens the dark rooms and is very satisfactory from the standpoint of wear but it is much more expensive than plaster.

One of the principal problems in a station is the floor surface. Wood holds and absorbs the dirt while varnish is soon scratched and worn off by the cinders carried in by the passengers. Where wood is used it should be either maple or edge-grain pine. Composition floors are used extensively; they give a hard, impervious surface, but their wearing qualities are not altogether satisfactory.

Some tile floors have given good results, but others have worn badly. owing to the cinders becoming ground in, causing the surface to craze and discolor. Floor tile should be vitrified in order to wear satisfac-

torily. Ticket offices should have wood floors, while vitrified brick floors give the best wearing surface for baggage rooms.

In the smaller stations, stoves are generally used for heating but they are not to be recommended, except in very small stations. Hot water heating plants are more satisfactory than steam, but are recommended only where there is an attendant on duty for the full 24 hours. In the colder climates, if the fires should be allowed to die out, the radiators, being full of water, would freeze and burst. A low pressure steam plant is very satisfactory and is to be recommended where an attendant is not on duty the full 24 hours. Should the fires die out, the steam condenses and the water returns to the heater in the basement where there is very little likelihood of its freezing. With a low pressure steam heating system there is practically no more danger than with a hot water system. Damper regulators are recommended for either hot water or low pressure steam heating systems, as they not only save coal, but they also regulate and provide an average temperature in the waiting rooms.

Frame Station, Chicago, Burlington & Quincy R. R.
Stucco Exterior, Metal Roof, Cement Tile Floor, Plaster Interior.
(Caretaker's Rooms Up Stairs.)

Where there is no convenient siding, a coal hole should be provided in the platform adjacent to the station so that coal shoveled from a car on the main track to the platform can be delivered directly into the coal bin in the cellar. It is common practice to allow ashes to collect in the cellar until a convenient time to remove them. It is recommended that in all structures except those strictly fireproof, means be provided for the storing of ashes, as fires are very numerous because of the habit of storing the ashes in the cellar.

Electricity for lighting is always recommended where it is available. If this cannot be had gas is recommended. In small stations only would we recommend the use of oil lamps.

Sanitary plumbing is recommended, and where there is no sewer connection a septic tank should be provided Another substitute is a chemical closet which is being used by a number of roads

Where a drinking water supply is available, drinking fountains should be provided, preferably one in the women's room and one in the men's room.

Platforms should be not less than 10 ft. wide. In front of the sta-

tion building they should be not less than 16 ft. wide and as much more as can be consistently allowed. There is much difference of opinion in regard to the character of platform to be provided. Vitrified brick is quite generally used, but many roads prefer concrete. One feature in favor of a brick platform is that if settlement occurs or if any of the brick become broken they can be repaired more easily than if the platform is built of concrete.

On double track roads two platforms are necessary, and where there is only one agent it is recommended that a subway be provided to enable passengers to reach the platform opposite the station proper. The size of the subway must be determined by the amount of traffic to be handled. A waiting shed should also be provided of a size and quality in keeping with the main station where double track exists. At all such stations an inter-track fence should be installed to keep passengers from crossing the tracks at grade.

Umbrella sheds are used quite extensively, but, because of the necessary side and overhead clearances that must be allowed, they do not give adequate protection in bad weather and it is doubtful whether the expenditure is warranted.

Brick Station on the Chicago, Burlington & Quincy R. R. at Riverside, Ill.

Wires.

When it can be arranged it is best to have the telegraph, telephone and electric light wires carried under ground from some conveniently located pole to the station. There are a number of comparatively inexpensive materials on the market now that can be used for this purpose.

M. A. Long,
E. B. Ashby,
G. W. Andrews,
J. B. Gaut,

Committee.

Brick Passenger Station at Somerset, Ky. Queen & Crescent Route.

Brick and Stucco Passenger Station, Chippewa Falls, Wis.
Chicago, St. Paul, Minneapolis & Omaha Ry.

Passenger Station at Bellwood, Pa., Pennsylvania R. R.

Concrete and Stucco Station at Briarcliff, on the New York Central R. R.

Concrete Passenger Station at Hopatcong, N. J.,
Delaware, Lackawanna & Western R. R.

Concrete Passenger Station at Greensville, N. J.,
Delaware, Lackawanna & Western R. R.

Concrete Passenger Station at Pocono Summit, Pa.
Delaware, Lackawanna & Western R. R.

Brick Station on the Delaware, Lackawanna & Western R. R., with Separate Waiting Rooms on the Opposite Track

Passenger Station at Hibbing, Minn., Duluth, Missabe & Northern Ry.

Brick Station with Tile Roof at Perry, Oklahoma, Atchison, Topeka & Santa Fe Ry.

Passenger Station at Orchard Park, N. Y., Buffalo, Rochester & Pittsburgh Ry.

Passenger Station at Springville, N. Y., Buffalo, Rochester & Pittsburgh Ry.

Station at Hazen, Oklahoma, Chicago, Rock Island & Pacific Ry.

Frame building 24 ft. by 60 ft. on concrete foundation. Brick veneer 5 ft. high,—stucco on metal above. Green interlocking tile roof; flat portion tar and gravel. Maple floors; (baggage and express rooms, concrete floors). Hot water heat. Electric light.

Passenger Station at Stoughton, Wis., Chicago, Milwaukee & St. Paul Ry. Hollow tile on concrete foundation. Trimmings, dark face brick. Finish,—exterior, stucco;—interior, plaster. Shingle tile roof.

Brick Passenger Station with Stucco Gables, Chicago & Northwestern Ry., at DePere, Wis. Concrete Foundation, Maple Floors (Tile closet floors), Transite Asbestos Shingles, Steam Heat, Electric Light.

DISCUSSION.

(Subject No 9. Station Buildings for Passenger Service Only.)

The President:—Has any one anything to say on this subject?

W. M. Camp:—Electricity for lighting is always to be recommended, where it is available. As a rule, railroad stations are poorly lighted. The ceiling in many of the stations is high, and the electric lights are usually put up against it, too far above the heads of people to be effective. The lights ought to be behind the seats, and not in front of people as they are seated. I noticed in the Lehigh Valley station at Wilkes-Barre, Pa., not long ago, that the seats were placed back to back and the lights were arranged over the backs, so that any one who wanted to read had light from the right direction. I think that toilet rooms also ought to be well lighted, both night and day, and they should always be located at outside windows. One will find that old-fashioned iron-bound seats are still put in against the walls in some new stations The next thing to torture for a tired person is to have to sit erect in one of those old-fashioned seats. Seats in public places should be made comfortable, and the back should tilt somewhat to the rear. One often finds that very little attention is given to some of these things, which really amount to more in securing the good will of the traveling public than the elaborations of architects on the interior finish and decorations.

J. S. Robinson:—I would like to see all electric lights on the walls. However, if the lights are placed there, the bulbs are likely to be taken out and sold.

R. H. Reid:—There is no room for argument on the desirability of the arrangement suggested by Mr. Camp. As to the practicability of some of the suggestions there may be a question. The question of the ceiling lamps suggested by Mr. Robinson can be remedied possibly by placing them high enough above the floors on the side walls so they cannot be reached by thieves, and yet they can be maintained. If it is desirable, some can be placed over benches in the reading room, or dropped from the ceiling and still keep them high enough to be out of reach.

L. D. Hadwen:—It seems to me that it is pertinent to consider the materials used in floors, from the standpoint of indestructibility. In some depots it would seem that a floor is giving entire satisfaction but it cannot be kept clean easily. The trouble with most of the composition floors that I have read about is on account of the manner in which they are laid. Many of the failures are due to defective laying. Also in some floors the right mixture is not employed.

E. C. Morrison:—On the division of the Southern Pacific that I work on we put in a tile or a concrete floor. The general tendency is to use tiling, but we have a dozen artificial stone floors.

The President:—The Southern Pacific has placed quite a number of concrete floors in waiting rooms, closets, and so forth. In most cases the floor is laid like a solid floor. Some of these stations have been in service three or four years and the floor is perfectly satisfactory.

J. P. Wood:—I would like to ask if any of the members have had any experience in taking out a wooden floor and putting in a concrete floor on the wood filler, between the joists.

D. B. Taylor (B. & O.):—I have constructed them in such a way, and I found that we escaped the absorption into the wood which was a great advantage.

W. M. Camp:—I have noticed some of the floors in small stations, more particularly because they were in small towns. I look upon them as a great improvement. They were not the natural color of the concrete, but were gray, and ran up to the wall without any crack or crevice for the filth to lodge in. Where the rooms are built directly on the ground, I would imagine that

considering the cost and the multiplicity of stations, the concrete floor can probably not be improved upon.

Jas. Gratto:—In some stations we have a room about 10 ft. by 15 ft., furnished with lavatories, a couch, and a couple of chairs for ladies and children, with a matron to take care of them. We also have the standard station seats, and a drinking fountain.

The President:—I think no one will deny that there should be a ladies' retiring room, with a regular rocking chair and other chairs, and a matron to look after it in stations in towns of three or four thousand people.

Jas. Gratto:—In the last three years we have made great strides in taking care of our passengers, in the way of station lighting, heating and so forth.

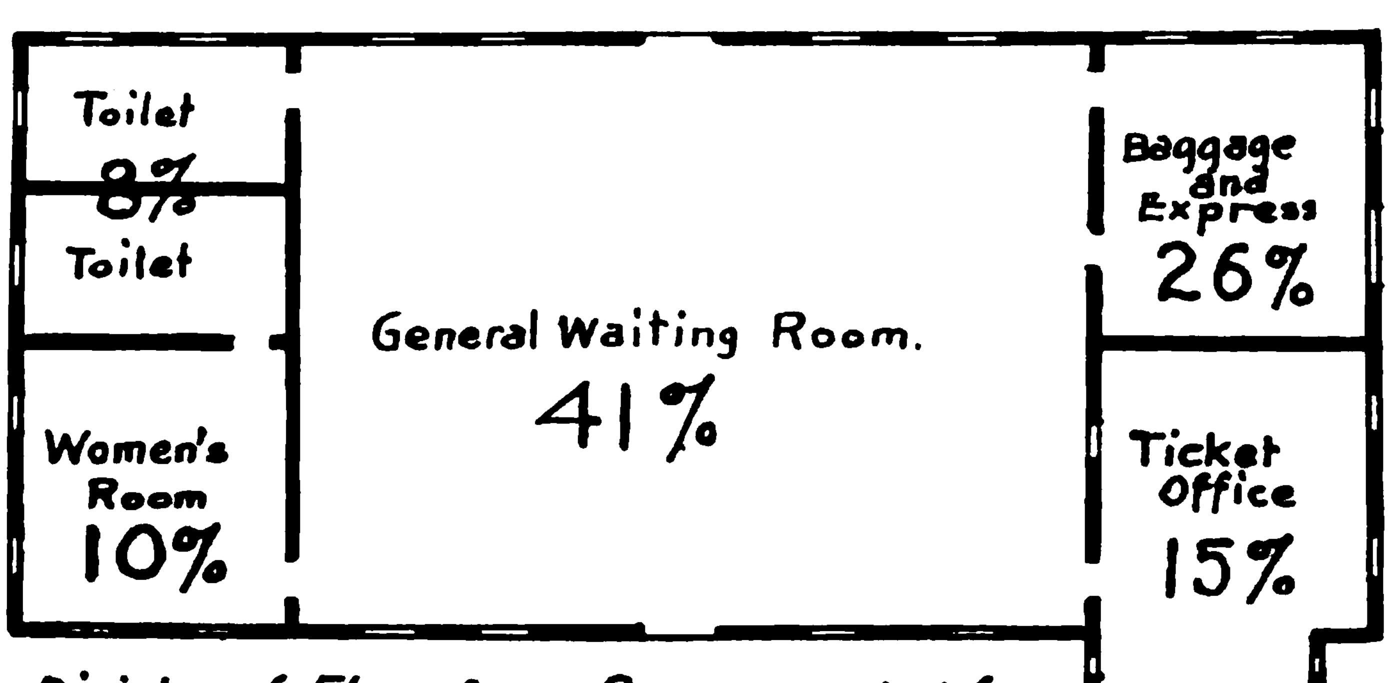
E. C. Morrison:—At Watsonville Junction, we ripped up the flooring and put in concrete flooring, except in the men's toilet where there must be a tile flooring.

Wm. Spencer:—I have in mind a station on our division. where there is a wood-filled concrete floor, built in with granite chips. The chips are polished. This floor has been in nine years and has given good satisfaction. There is not a break in it yet.

C. H. Fake:—I would like to know the experience, or objections, if any, to the use of asbestos or asphalt shingles.

The Secretary:—Mr. Robinson can probably tell the experience the North Western has had with asbestos shingles on some moderate sized stations west of Chicago.

J. S. Robinson:—We use both asbestos and asphalt shingles with good success. As for wear and general efficiency both the asbestos and the asphalt shingles are good.



Division of Floor Area Recommended for Passenger Stations with One General Waiting Room.

Fig. 1. (See page 180.)

SUBJECT No. 10.

ECONOMICAL HANDLING OF CONCRETE ON SMALLER JOBS.

REPORT OF COMMITTEE.

The subject assigned to this committee did not offer much opportunity of gathering comparative data and it seemed best to frame our inquiry so as to secure information regarding representative practice in the handling of the smaller jobs of concrete work, and to this end the committee sent out a list of questions which is incorporated in the appendix to this report. By getting an insight into the methods employed on different roads, it was thought that we would, at least, have a basis for discussion as to the manner of effecting economies in this class of work.

To limit the scope of the subject, it was decided that only such work should be considered as did not exceed 200 yds. in volume and which would not warrant the installation of a special plant.

Unfortunately, owing to the scattered personnel of the committee, there has been very little opportunity for conference between the different members and the late date at which a number of the replies came in made it impossible to give the proper amount of time to digesting it and formulating definite conclusions; moreover, lack of time has prevented the chairman from submitting this report to the other members of the committee and it may, therefore, fail to express their views. It is hoped, however, that what has been gathered will serve to bring out a discussion on the methods which promote economy.

Replies were received from 41 different railroads, representing a total of 127,500 miles, covering practically all the different railroad conditions that would be encountered in the North American continent, while an interesting response was received from the New South Wales Government Railways and Tramways; the latter, together with some of the more complete replies received, have been incorporated in the appendix as illustrating practice in different sections of the country.

Some of the replies giving accounts of specific pieces of work suggest the thought that individual examples of this kind might be submitted another year as we, undoubtedly, can get much useful information by discussing the conduct of individual pieces of work at our meetings, giving opportunities to see how the other fellow does it.

A summary of the replies received shows that 31 roads, representing a mileage of 100,280, in general, handle their small concrete work with their own forces. Two of the roads having a mileage of 2,839 miles handle such work exclusively by contract. Six roads with a mileage of 24,403 use both methods, being governed by the nature of the work, its volume and convenience in handling, the question of labor supply playing an important part in the method used. On small jobs of this character, contractors are often not in a good position to compete as the work is connected with operating features and has to be adjusted to suit them rather than to suit the convenience and economy of its conduct. The question of safety and the desire to have the company's own employés handle construction under operated track or in the yards and shops have an important influence in eliminating contract work in many instances.

While a very large proportion of the railroads replying handle this class of work themselves, this should not be taken as entirely typical

of general practice as, doubtless, many railroads who handle all their work by contract failed to respond to the inquiry.

In considering the relative economy of handling work of this character by contract or by company's forces, the fact that the contract price does not cover all the incidentals in connection with the work should not be overlooked. Company work is often conducted at a disadvantage from the point of economy in order to facilitate the work of other departments and delays which company's forces may experience would result on contract work in large bills of extras which do not appear in the contract price.

It would seem that the practice of using the ordinary bridge and building maintenance forces to handle concrete work, incidental to other work they may be doing at a given point, would tend to economy even though their labor is higher priced than that of the concrete men, as, in this way, the moving expense of a second crew can be eliminated and the entire work cleaned up at one time. On the other hand, there are many small pieces of work such as the laying of sidewalks and crossings where the most economical results can be obtained by availing oneself of the services of local contractors.

In regard to organization, 25 roads replying employ divisional forces, whilst 11 report a departmental organization. The supervision is generally furnished by master carpenters or division superintendents of bridges and buildings and in some instances by the assistant engineers of the engineering department. The preponderance of sentiment seems to be in favor of having such small work handled and supervised by the division forces. In some instances it is the practice to employ the carpenter forces to handle the smaller concrete jobs hiring additional laborers where necessary.

The rates paid, of course, vary very largely according to the section of the country. The rate for laborers running from 13½ to 25 cts. an hour, for carpenters from 21 to 35 cts. and foremen are paid from $90.00 to $110.00 per month. The size of a gang varies from 6 to 12 men with one or two carpenters and a foreman. In some cases handy men are employed having a rate somewhere between that of the laborers and the carpenters and usually being men promoted from laborers having the longest service. The best organization is obtained where the men feel there is an opportunity for promotion. It is difficult to get adequate carpenter help on work of this kind and a larger proportion of carpenters in a crew would promote the economy of the work could they be obtained.

Of the replies received, 31 indicate that they are able to organize the work so as to admit of a regular program thru the season while 5 are unable to do so. Three handle work of this kind by means of regular floating gangs. In most cases a program is mapped out in the Spring and forces organized to cover the season's work though it is sometimes necessary to organize to take care of individual jobs. A desirable way of taking care of such small jobs would be to have a crew organized under the district authority to take care of the work on each district or division where the volume of work makes this justifiable. Some roads keep a regular gang all the year handling this class of work and moving from one division to another. This method is used on the Chicago, Burlington & Quincy, floating gangs moving from one division to the other cleaning up as they go. On the Chicago, Rock Island & Pacific, regular bridge gangs are used for small work. A feature called attention to by the Nashville, Chattanooga & St. Louis is the use of suitable boarding cars for the crews and greater attention to this feature would tend to economy by making the conditions of the work more attractive and tending to hold men permanently. Efforts in this direction will help to solve the labor problem more than almost any other factor. The smaller jobs demand a better quality of labor than pieces of concrete work of greater magnitude where the men do not need to be as adaptable. The

change in the commencement of the fiscal year from June to January would promote the economy of this class of work by making possible a systematic budget and definite program which could be commenced as soon as the Spring opened up instead of crowding much of the work towards the end of the year when both labor and weather conditions are adverse. A frequent obstacle to economy is the sudden decision to do work which has not been anticipated in the regular program and necessitates expensive moves.

In the matter of providing material there is considerable divergence in practice. The 23 roads make use of local aggregates wherever possible but in a great many instances the territory traversed does not provide suitable aggregates. Examination of any possible local aggregate is desirable as economy can often be effected by the use of local material even though it may demand an increased consumption of cement.

The question of haul of company material has not in the past always received as much attention as it should and if the haul is figured on a ton mile basis, it will often be found cheaper to use a different aggregate from that which is most desirable from a construction standpoint.

The cement for these small jobs can often better be furnished from local stock rather than have direct shipments come from the mill. Some roads permit the purchase of local supplies for small work and as the question of prompt delivery is often more important than price, in the ultimate economy of the work, considerable latitude in this direction seems desirable. It is impossible for the purchasing agent on a large system to be in close touch with the local sources of supply that may be available and it would seem well to give the local offices some discretion in this direction. It takes but little delay in getting supplies or material on a small job to run up the cost unduly and the matter of forethought in ordering material and allowing ample delivery will go far to securing cheap work.

Generally, material for structures on the line appears to be handled by way freight. Where crews can be combined and material ordered sufficient for a day's work train service, it is preferable to handle the material for 3 or 4 jobs rather than handle it by regular train with a small force, as work train service forms a material item in the cost of all such work.

No mention is made of team haul for material, but there will be times on busy lines when it will be cheaper to get material delivered in that way rather than to incur work train service.

The following from Mr. Crawford of the Canadian Northern is of interest:

"For tank, station foundations and scale pits, etc., suitable pit-run concrete gravel is obtainable in some one of the company's pits on nearly every district. Sometimes we find it necessary to haul said material a considerable distance in order to get the desired material which consists of a good clean mixture ranging from sharp sand to stones the size of hens' eggs in the proper proportion to make a good concrete with 5 sacks of cement to the cubic yard of concrete in place. For reinforced concrete culverts and other jobs where thin masses and strength are required, special grades of sand are obtained from company's pits and crushed granite used instead of gravel. All material for small jobs is loaded from company's pits on to cars by section men, extra section men being put on if necessary, and a qualified man from the bridge and building department supplied to watch the loading and see that only proper material is loaded. Crushed rock is generally procured by purchasing granite field stone from farmers, and where obtainable, loaded off the right of way by company's forces, the average price paid is $4.25 per cord loaded on to cars on side track. Stone is hauled to headquarters and crushed by yard crew at a time when other work is not pressing. One portable rock crusher should be sufficient to meet the requirements of four superintendents' districts under ordinary conditions

and can be shipped to the different districts as required. A crusher that can be driven by a 20 h. p. oil or gasoline engine is the most advantageous; such a crusher has a capacity of about 40 yds. per day. Both crusher and engine should be on trucks so they can be moved about quickly and cheaply.

"If work is handled properly, we can crush our own rock considerably cheaper than we can buy it, the cost averaging about $1.50 per yard on cars; and besides have the advantage of not having to wait on some one else to supply the material when required on short notice. Some piece of unoccupied trackage should be selected for crushing, so if the crushed material is not run from the crusher elevator on to cars, it can be run into a pile and left close to the track ready for loading when required."

To take the most advantage of the train service, one road is in the habit of doubling up its crews and getting the assistance of section men whenever material is to be unloaded. On the Elgin, Joliet & Eastern it is the practice to distribute material to the various jobs before the construction crew is on the ground. In many cases work of this character will be located in yards and terminals and the material can be moved by switch engines. It is essential that the foreman who handles the material should be in close touch with the train dispatcher and be informed as to just what train service he is going to get. Many expensive delays are due to promised train service being postponed. On the Boston & Albany work train service is handled by the superintendent of bridges and buildings coöperating with the supervisor of track who has gangs assigned to work trains permanently. This would seem an economical arrangement where there were a sufficient number of jobs.

As to average costs for this class of work, the conditions will vary so much that figures do not mean much. Prices from $5 to $8 per yard for mass masonry and $7 to $20 for reinforced masonry which are quoted show the wide range, and in the case of the lower figures, doubtless, no account is taken of overhead charges and work train service.

No very complete lists of the tools considered essential for a small concrete outfit were given. The following which is typical of an outfit on small work on the C., M. & St. P. Lines may be taken as an example:

1	Concrete mixer	2	7/8 in. bridge augers
10	Wheelbarrows	3	Tubular lanterns
1	Cant hook	1	Single bit axe
50	Ft. 1 in. water hose	2	Water barrels
1	Small track jack	6	Heavy galv. water pails
1	Combination vice	1	Gaso. driven diaphragm pump
1	Hand axe	1	Pinch bar
1	Double bit axe	2	Combination nail pullers
1	Sheet pile pounder	12	D. H. R. P. No. 2 shovels
1	Timber bar	1	Measuring box
1	Cross-cut saw	1	Tool box
1	No. 4 sand screen	1	Steel broom
12	D. H. S. P. No. 2 shovels	3	Common brooms
6	Pr. knee boots	1	Stone mason trowel
1	D. H. spade	1	16 ft. straight edge
1	8 lb. sledge	1	Plasterer's trowel
1	16 lb. sledge	2	Pr. wire pliers
1	8 ft. straight edge	200	Ft. 1 in. line
1	Grindstone and frame complete	6	Track chisels
4	Claw hammers	2	12 in. monkey wrenches
4	Prs. carrying hooks	2	18 in. pipe wrenches
2	Heavy mortar hoes	1	Set 8 in. double blocks for 1 in. line

The outfit should be adjusted, as far as possible, to the character of work the crew will be called upon to do and the hauling of all excess equipment and surplus second hand lumber, etc., from other jobs be avoided. Nearly all roads favor the use of a small mixer in any concrete outfit. In most cases the carpenters are required to furnish their own tools but it is economy to have a liberal supply of hammers, saws, etc., on hand in an outfit so that laborers can be pressed into service, sheeting up the forms, etc., when they would otherwise be waiting. For crews making frequent moves, a tool car will save much handling as small amounts of cement and lumber can be carried along with the outfit and only such tools as are necessary for the job in hand need be unloaded. The cost of water required for many small pieces of concrete work is out of proportion to the volume and proper consideration to the best way of furnishing this will often give an opportunity for economy. A small steam force-pump that could be operated by steam from the mixer boiler or a small gasoline driven pump will pay in most any outfit.

The size of mixer recommended shows considerable variation, evidently, larger work being considered in some instances in the replies. Only 6 prefer hand mixing for small work. Sixteen recommend mixers with from 6 to 9 cu. ft. capacity unmixed charge. This corresponds to a 1-sack batch mixer. Eight prefer a half yard or 2-sack batch mixer and two use ¾ yd. machines.

There are no reports on the use of hand operated machines and it is questionable whether such a device is economical when power from small gasoline engines is so readily available. One road reports using a 4-ft. mixer and it would seem that a low charging gasoline operated mixer of such a capacity might be used to advantage on many small jobs. A number of these small mixers have been used by contractors for sidewalk work and it was hoped that more information would be obtained relative to their use on railroad work. The replies received do not indicate any preference as between gasoline and steam driven mixers, but for light work the reduced dead weight of the latter type of machine and the fact that no engineer is required to operate it makes it the most suitable.

The opinions as to the minimum sized job on which the use of a mixer is justifiable vary widely. Four roads recommend using some form of mixer for quantities as small as 5 yds. Six would use one where the quantities are from not less than 10 to 30 yds., 5 set 50 yds. as the limit and 6 consider 100 yds. a minimum. This is a matter that depends on available equipment, but there is little doubt that the small mixers now on the market make machine mixed concrete possible on almost any work no matter how small. The Chicago, Burlington & Quincy expect to try out a small mixer weighing a ton, complete with the engine, and the difficulty in holding labor on hand mixing will undoubtedly lead to the more general use of small mixers.

Among the special appliances desirable on this class of work are mentioned diaphragm pumps driven by small gasoline engines and the same engines have been adapted to use for driving force pumps. One road has a gasoline hoisting engine with a mixer which is adapted to running a centrifugal pump where much water is to be handled. Where a steam mixer is used the boiler can furnish steam for a siphon which will avoid the use of some form of power pump.

As to the economy of unit construction on small work, not much information was furnished, though there were expressions in favor of unit construction for culvert pipe, curbing, posts, water troughs, sills, piles, deck and trestle slabs, all of which can be moulded to advantage in a central plant and shipped as separate units to the point where they are required. The C., M. & St. P. have made use of unit depot foundations built at a central point and shipped to the site for erection so that the carpenter crew can erect the entire structure. They also make use

of concrete standpipe pit covers made in sections and of concrete backwalls for filling the central openings of backwalls on permanent abutments left for falsework purposes.

The Buffalo, Rochester & Pittsburgh states: We have found it very economical to use unit construction, built at a central point, for all foundation, posts, poles, pipe, etc., not exceeding a bulk of 5 yds., also floor slabs for solid floor bridges. This unit construction includes automatic signal foundations, distant signal foundations, crossing bell foundations, culvert sign bases, concrete flume, piers for all small buildings, concrete pipe, (12, 18, 24 and 36-in. diam.) concrete fence posts and corner fence post braces, electric light poles, ornamental lamp posts, mile posts, whistle posts, etc.

The Nashville, Chattanooga & St. Louis give the following: Have not gone into unit construction extensively. Have used it only for sills and water tables in buildings and for slabs which can not be built in place. Prefer to build in place where possible. We are, however, preparing to place slabs of 34 ft. in length and 6½ ft. wide by the unit method.

The Chicago & Eastern Illinois state that where truss bearing, coping and smaller blocks only are required they make them at headquarters and handle with derrick car. In general, the application of unit construction is made on subway and concrete trestle construction in which the economy of separately moulded and erected units is well demonstrated.

Unit forms make for a saving in form labor in many instances. The following roads make use of them on arch culvert work: Canadian Northern, Elgin, Joliet & Eastern, Canadian Pacific, Louisville & Nashville, Northern Pacific, Chicago, Milwaukee & St. Paul, Pere Marquette, and Missouri Pacific.

The New York Central and C. M. & St. P. Ry. make use of unit forms for small pier foundations, turntable pits and work of similar character where there is considerable duplication. The Queen & Crescent report using unit forms for buildings. While unit forms are in some cases economical, generally the run of small work is not such as to afford sufficient duplication to work out economically.

The cost of form lumber composes a large item in material costs for small work and the attempt to reduce weight by using light material and the employment of heavier material to insure re-using several times appear to balance each other. There are about as many roads favoring 1-in. lumber as 2-in. Some employ a cheap grade of 1-in. hemlock for backforms. To avoid carrying a variety of stock it is preferable to limit form lumber to as few standard sizes as possible. The C., M. & St. P. uses 1 in. by 8 in. SIS & 2E No. 1 lumber and 2 in. x 8 in. D & M sheeting with 3 in. by 6 in. studding. The Boston & Albany, 1¼ in. x 9 in. spruce SIS D & M with closed studding. The quality of lumber required is not generally given. The Buffalo, Rochester & Pittsburgh, however, uses No. 2 hemlock and oftentimes a cheaper grade of lumber can well be used for concrete forms where appearance is not a matter of moment. Any class of second hand lumber will serve for the backing of forms. The Canadian Northern and St. Louis & Southwestern both use 1¼ in. shiplap. The Erie uses 1¾ in. hemlock SIS with 3 in. by 4 in. studding,—the studding being placed 2 ft. centers. The Chicago & Northwestern uses 1 in. and 2 in. boards with 4 in. by 6 in. posts and bracing. The Elgin, Joliet & Eastern uses 2 in. by 4 in., 2 in. by 8 in. and 1 in. by 6 in. for small work. On small work the use of light lumber to avoid expense in handling and transportation makes for economy. Instances often come under observation where a large amount of second hand lumber is moved with an outfit which merely adds to the cost of the work without being of any benefit and supervision of gang foremen to insure their shipping in surplus lumber will be well repaid.

No mention was made of the use of small steel forms which, doubt-

less, in many instances would show economy where the work is simple and involves frequent duplication.

One of the most fruitful means of getting economical work is a good system of cost keeping and the securing of data which will show the relative performance of different crews and often there appears to be but little opportunity of those directing the work knowing the actual costs and comparing the performance of different crews. In 13 cases replies indicate that foremen are kept advised of their relative performance and of the cost of their work. Four roads have systems of daily reports from each crew. On 14 roads there is only opportunity of ascertaining the costs in a general way and no complete records of performance are available to guide those having charge of the work, while in 5 cases, no cost data of any kind were available. An analysis of actual costs that are available whilst the work is going on will enable the supervisor by consultation with his foremen to point out the portions of the work where they have been weak and where better results can be obtained in the future. It is labor data which are most important as materials will show comparatively little variation. Friendly competition between different crews will oftentimes accomplish surprising results. The following from the Canadian Northern is of interest: Time books and invoices are handled in the B. and B. office and the actual cost of each job is always available. Foremen are advised as to the cost of jobs which they have handled; also the cost of similar jobs handled by other foremen; in this way we are able to procure competition between different foremen when several jobs of the same class are handled. I find it also beneficial to both the company and the men to allow foremen to come in contact with each other's work as much as possible so that they have the privilege of interchange of views, also to see how the other fellow does it. Concrete construction gives a wide and interesting field for discussion and the more a man sees and hears of how others do it, and the more discussions he has on the subject with concrete foremen, the better chance a man has to gain further knowledge, thus being in a position to do the work more cheaply. The St. Louis & San Francisco are taking steps to get accurate cost data covering the cost of small jobs done by company forces by employing timekeepers.

The following quotations indicate what are reported as especially helpful in reducing costs:

Boston & Albany:—Close supervision; having a good cost man on the job to keep a unit cost of work as it progresses and having boarding outfits for the men to live in so that no time is lost by men traveling over the road to and from jobs.

Detroit & Mackinac: Pouring directly into forms, rather than wheeling from the mixer to forms. The use of 1-in. lumber for forms, and setting studding closer together.

The Pere Marquette have found dynamite to be used to good advantage for excavation in hard clay ground.

F. L. Burrell, C. & N. W. (Lines West):—Standardize the forms, and the plans to conform with them, cut out the crushed rock proposition, using the local ingredients; the sand containing such gravel as found in it locally, and make a little stronger portion of cement. On jobs of 8 or 10 yds. this makes the labor on the concrete work, including the forms, average $1.40 per yd., in place, and the material $3.55 per yd., as against $4.51 per yd. where crushed rock is used.

Mr. Markley of the C. & E. I., emphasizes the use of good live foremen, up to date mixers and giving the men in charge plenty of latitude.

Mr. Horning of the Michigan Central speaks for careful supervision and instructions.

Mr. Montzheimer of the Elgin, Joliet & Eastern has used a locomotive crane for handling all materials and plant for this class of work and believes that this materially reduces the cost of labor.

Mr. Crawford of the Canadian Northern says:—Try and get fore-

men interested in concrete construction, get them to subscribe to some journal that gives interesting articles and illustrations on concrete work. This has a tendency to develop their present abilities and keep the work freshened up in their minds, and instead of forgetting something that they had known before, they get some new ideas that may help them on the next difficult job they have to handle.

J. J. Taylor, Kansas City Southern:—Have a foreman in charge that has sufficient practical knowledge to be responsible for putting in and the taking care of traffic over the falsework where it becomes necessary for him to cripple the structure. In other words, to have combined in the one foreman a man that can be relied upon to take care of his own falsework as well as supervise the construction and installation of the concrete. Provide them with camp cars and wherever the job is of sufficient size and other conditions will permit, spur the outfit out as close to the work as is convenient to eliminate the delay and expense of hand car haul to and from work. Allow the foreman to furnish the laborers provisions, allowing the laborers to mess or batch themselves in the cars; use negroes as laborers and by employing the foregoing means, we are able to get the pick and choice of the negro laborers.

On the C., M. & St. P. some of the devices found helpful have been standard form castings and form bolts used in connection with wire ties, the wire ties being twisted to required lengths in a frame so as to be ready for use instead of doing this in place. Double-headed nails for forms have been found convenient where sheeting has to be removed frequently but not used to any great extent. Motor cars have also been found desirable for concrete crews and their more extended adoption seems desirable for forces employed on this class of work.

The following are some of the suggestions made with a view to improving practice on this class of work:

Elgin, Joliet & Eastern:—As a rule, current railway practice on small jobs of concrete work could be improved by the use of more clerical work and engineering office work, in making out bills of material to be used and keeping costs on labor and material actually used.

Chicago & Northwestern:—More improved equipment in the way of power operated pumps and mixers. Hiring efficient foremen, and making the position of foreman worth while for a capable man.

Chicago, Rock Island & Pacific:—The forces directly in charge of work if given more information about what is expected of them and more information as to what others may be doing, the class of work and the time consumed may be considerably improved.

Northern Pacific:—As far as practicable, have this work done by one crew.

St. Louis & San Francisco:—There is frequently a considerable waste in concrete and also other work due to the fact that a crew is started to the work before all material is on the ground, which is required to carry out the work. Before a crew is started out, it should be seen that all material is on hand or will unquestionably be on hand before it is required and suitable supervision should be provided for carrying out the work in the field.

Denver & Rio Grande:—Reforming of the management so as to be allowed to keep one gang on the work.

Buffalo, Rochester & Pittsburgh:—As a rule, speaking of all roads, better living quarters should be provided in the way of camp equipment, etc., better tools and material should be furnished, and closer supervision should be given to the work.

Boston & Albany:—The labor question at present is very serious and it is difficult to find men. Would suggest that a living car be fitted up out of a coach, one end to be fitted up for the foreman and cook and carpenter for form building, and the other end to be fitted up for laborers; one box car for tools and material. Cars to be placed as near the site of work as possible.

Detroit & Mackinac:—The use of unit construction on work smaller than 10 or 15 yards.

The closest supervision of work with a study of the individual conditions for each job, improved accommodations for men, simplification of forms, closer coöperation between the operating and construction departments, starting the fiscal year with the calendar year to provide greater time to make up programs of work, greater latitude in the rating of men, would seem to offer lines along which practice could be improved on this class of work.

The employment of time when the weather is inclement to sharpen tools and repair equipment should be taken advantage of to keep the men at work and avoid discontent which would otherwise occur on account of reduced hours. The foremen should plan work of this kind so as to keep the men employed even though they can not be working on the job.

Comparatively few descriptions of individual pieces of work were received. It is hoped, however, that discussion will bring out further information of this character.

Mr. Stuart of the Buffalo, Rochester & Pittsburgh, gives the following:—A very economical piece of work which was under my supervision was the placing of automatic block signals on the Buffalo Division of our road from Buffalo Creek to Ashford, a distance of 45 miles. I will describe briefly the method of placing the foundations.

The foundations, of which 96 were required, were all made at East Salamanca at which point the concrete plant for the entire road is located and when thoroughly cured were loaded on cars and shipped to the Northern terminal of the division which is Buffalo Creek. A work train with derrick car then picked these cars up at that point and proceeded south over the division, distributing the foundations and other necessary material at points which had been previously staked out. As soon as the material and foundations were distributed a crew was started at Buffalo Creek working south and setting these foundations. This gang was equipped with a tripod and as they went along excavated for the foundations and set them.

There were 96 foundations made at a cost of $2.20 each, which, together with the necessary material, etc., were distributed over the division at a cost of $89.75 for labor and a work train charge of $120.00. The excavating for these foundations cost $84.33 while the setting, backfilling and cleaning up amounted to $188.96.

The battery wells, bracket signal foundations, switch indicators, battery chutes, etc., were all placed in a like manner as were also the signal poles.

Mr. J. P. Wood of the Pere Marquette cites a culvert where by constructing platforms on the slope of the dump under the pile bridge it was possible to handle all the aggregates by gravity and to spout the concrete directly into the forms.

F. L. Burrell of the Chicago & Northwestern gives the following examples:—At one place we had a job of about 50 yds. for concrete foundations for a 15 ft. stone arch located in the woods. Large trees stood on each side of the ravine which was to be filled. We attached a common 2-in. rope cable to the trees on the opposite sides of the ravine, placing two snatch blocks in a frame as carriers. The cement was mixed at a low place near the water, keeping the men in the shade, depositing the concrete in place by means of the cable and a drop bottom box of ½-yd. capacity. The mixing was done by 14 men who kept two buckets going. The labor for mixing and placing the concrete ranged from $0.87½ to $1.10 per cu. yd. The difference was due to the longer or shorter distance from the point of mixing.

At another place where the height of the bridge was 37 ft. the concrete was mixed dry on the bridge. Hose was attached to barrels containing water, allowing the water to flow into the mass as it passed down

a gravity home made mixer and deposited by chutes. The cost of this was $0.80 for labor mixing and placing the concrete. The home made mixer was 4 ft. wide at the top, and tapered to 3 ft. on the bottom. Deflecting plates of wood were placed at intervals of 14 in. on alternating side of the box with spikes driven into the deflecting plates to mix the mass.

Mr. Green of the Southern Pacific gives the following:—We have all kinds of mixers and always aim to have one on a job just the size that the concrete can be stood around the forms properly between batches; that is, if we are putting in a small arch and ¼ yd. is all that one man can place in shape, and tamp or spade in place while another batch is put in the mixer, that is the size of mixer to use, but if the job is large enough to work two men in the forms, then ½ yd. increase in size of mixer, according to bulk of concrete.

For small jobs such as pipe or small arches, we have a ¼-yd. batch mixer, weighing about 2,300 lbs., run by a gas engine on skids. This can be taken out from a station on a push car, skidded off on any flat spot close to the job, the closer the better. The hauling out of the mixer and placing can be done at the same cost as that of hauling out planking and building a hand-mixing platform, and the mixing done for one-half the cost of that done by hand resulting in a 50 per cent better job.

Doubtless, these examples will suggest others to members present which they can present in the discussion which the information and suggestions gathered together in this report is intended to stimulate.

L. D. Hadwen,
O. F. Dalstrom,
C. F. Green,
G. H. Stewart,
J. W. Wood,
Committee.

APPENDIX.

Questionnaire sent out:

March 8, 1916.

In order to secure data as a basis for its report on "Economical Handling of Concrete on Smaller Jobs," the undersigned committee are desirous of securing answers to the questions submitted below; and would ask that you furnish such information as you have, or pass the inquiry to the officer on your road in a position to do so.

To limit the field of inquiry we are confining our consideration to structures involving less than two hundred cubic yards of concrete and which do not warrant the installation of a special plant and have in mind miscellaneous work such as depot foundations, water tank foundations, scale pits, platforms, highway overhead crossings, small culverts, etc.

1. Is it your practice to build such work with your own forces or by contract? If both, what governs the choice?

2. Indicate organization adopted; whether divisional forces or departmental, together with manner of supervision.

3. Indicate make-up of crew and rates paid.

4. Are you able to carry on work according to a pre-determined program, or must floating gangs be organized to meet individual jobs as they arise?

5. How is material provided and to what extent is use made of local aggregates?

6. How is work train service handled and what is the average cost per yard of concrete in place on work outside of yard limits?

7. Give list of outfit and tools found most economical for handling work of this character.

8. What size mixer do you find most desirable for such small work?

9. What do you consider the minimum size job on which a mixer is justified?

10. What special appliances, such as gasoline pumps, etc., do you find it economical to employ?

11. To what extent have you found it economical to use unit construction with units built at a central point, rather than concrete poured at the site of the work?

12. Do you use unit forms and for what kinds of work do you find them economical?

13. What sizes of foundation and form lumber do you find best suited for small jobs?

14. What opportunities have those directing the work of knowing actual costs and comparing performance of different crews?

15. Are you able to secure competition between different crews and to what extent are the foremen advised of the cost of their work?

16. Describe any special features or devices you have found efficient in reducing the cost of this class of work.

17. What suggestions have you to make with a view to improving current railroad practice on small jobs of concrete work?

18. Should you have any small jobs, the handling of which has been specially economical, a description of their salient features will be appreciated.

As this circular is only being sent to one officer of a system, will you please make an effort to have it answered by the proper official so that our report may be representative.

Replies should be sent to the Chairman, care of C., M. & St. P. Ry., 1347 Railway Exchange, Chicago.

REPLIES FROM VARIOUS ROADS.

Reply of Mr. Hunter McDonald, Chief engineer, Nashville, Chattanooga & St. Louis:—1. All concrete work is done with our own forces unless outside parties are interested, such as cities and other railroads.

2. Up to two years ago our organization was departmental, all division forces on bridge and buildings reporting directly to the chief engineer. At present our organization is divisional. Division officers in maintenance of way department consist of a division engineer, in charge of all maintenance and construction, and reporting to him are a supervisor of bridges and buildings, track and signal supervisors and water supply foremen. The supervisor of bridges and buildings has charge of the concrete work. Under the supervisor of bridges and buildings are the foremen, who are in every instance promoted from bridge carpenters. These have under them one or more bridge carpenters, the proportion of carpenters and laborers depending upon whether their work is confined entirely to concrete work or to bridge work. We frequently do both with the same gang. In all gangs the men are paid graduated wages, and new men are employed only at the lowest rate. We board all of our own men, charging 35 cents per day, computing wages with this amount deducted. The price was fixed several years ago and is now too small. No deduction for board is made for rainy days or days when the gang, for other reason, does not work, but is on the job ready to work.

3. The rates less the board, which are paid the carpenter gangs, are as follows:

Foremen, ... $80.00 per month.
Asst. foremen, ...$2.25 per day.
Carpenters, ...$1.35 to $2.00 per day.

The rates paid the strictly concrete gangs, are as follows:

Foremen,	$80.00 per month.
Asst. foremen,	$2.50 per day.
Carpenters,	$2.10 per day.
Laborers,	$1.10 to $1.30 per day.

4. Yes. All of our gangs are floating, in that they live in boarding cars. We make an annual budget which is approved early in the year. Our work is adjusted so that we keep the same gangs thruout the year if possible. With a very heavy budget, we sometimes have to organize additional forces.

5. Aggregates are purchased locally wherever possible, but always subject to approval of the chief engineer, who authorizes contracts.

6. Work train service is sometimes handled by local and sometimes by special train. If possible, all material is handled in drop bottom cars unloaded thru trestles and elevated by hoisting apparatus in connection with charging device of mixer. Average cost about $5.00 per cu. yd.

7. Our standard mixer for this class of work is Chicago Cubical, six cubit feet, equipped with charging hopper and long track, the only other special appliances are a small trench pump operated by hand, a small gasoline engine and pump or hand pump for local water supply, and where water troubles are great, a centrifugal pump, sometimes operated by steam and sometimes by gasoline engine. No special tools beyond the ordinary ones are employed.

8. See No. 7. On some of the larger jobs a larger mixer would prove more economical, but as a general proposition where gangs are shifted about from one place to another, the small mixer is the best. All mixers are provided with detachable wagon wheels for use where jobs are distant from the track.

9. This depends largely upon circumstances and the availability of a mixer. We have used mixers for jobs as small as 50 cu. yd. with economy, but under most conditions 100 cu. yd. is about the limit.

10. See answer to No. 7.

11. Have not gone into unit construction extensively. Have used it only for sills and water tables in buildings and for slabs which can not be built in place. Prefer to build in place where possible. We are, however, preparing to place slabs of 34 ft. in length and 6½ ft. wide by the unit method.

12. If, by unit form, steel forms is meant, the answer is "no." Wooden forms are used for slabs and artificial stone.

13. We use old car sills for framing whenever we can get them and 2 in. pine, D-4-S, for sheathing.

14. The chief engineer's office makes occasional check on the performance of the different gangs on different divisions. Each job is carried out under a preliminary estimate which is more or less carefully prepared.

Variations from these estimates are followed up for causes. We have no organized bureau for determination of unit costs, but are now engaged in forming one, which will not only cover unit costs, but records.

Assistant engineers reporting to division engineers, and coöperating with bridge supervisors, stake out all work and look after quantities. No inspectors are employed as foremen are trained to do good work, and no other kind is done.

15. We do not encourage competition between different crews, as it puts a premium on bad work. The cause of high cost is ascertained and the foremen who persistently fall down are relieved.

16. I know of no special features or devices which we have employed except careful and conscientious supervision, and instruction of the men. I know at present of no plan by which our current practice

can be improved, but am always ready to consider and adopt any practical method.

18. Reference is made to pages 327, etc., of Gillett's Hand Book of Cost Data for detailed costs of some of our work.

Reply of C. E. Smith, consulting engineer, St. Louis, Mo.:

1. For some years it has been my practice to build such work with my own forces, as I found that contractors could not do the work as economically as company forces, for the reason that company forces were in a much better position to secure daily assistance from the operating department than a contractor, and the contractor was less regardful of the necessity of keeping out of the way of trains.

2. Wherever possible division forces were relied upon to do the work, under the general supervision of the general bridge inspector from headquarters, but on some divisions the superintendent or the supervisor of bridges and buildings, not feeling qualified, or not having the necessary equipment, insisted on the work being performed under contract, or by an organized force. Under those circumstances I have frequently organized special forces, and directed them from headquarters until fully organized, when the force would be turned over to the division for further handling. The taking over or organizing of such a crew by the division, resulted in more concrete work being done than otherwise.

3. The crew usually consisted of a foreman at $90 to $95 per month, with the necessary carpenters at $2.75 to $3 per day, and laborers at $1.50 to $2 per day.

4. In the first few years of the organization of this work by company forces, I found it difficult to carry on work according to a predetermined program, but at the present time the work is made to fit the gangs available, and a regular program is adhered to.

5. Local aggregates are used wherever possible, in order to keep down the cost of transportation. Other materials are secured at the nearest available point, or shipped from the nearest supply house—usually direct to the jobs.

6. As far as possible materials are unloaded in small quantities daily from local freight, and I would not consider it necessary, except in special cases on heavy traffic lines, to call a work train for a job having less than 200 yds. When work trains are called, however, preliminary arrangements are made with the operating department, and the construction gang is ready on arrival of the work train. I have found that where possible to get along without a work train, great economy has usually resulted.

Plain concrete $7 to $8 per yard; reinforced concrete $11 to $12 per yard.

7. The usual outfit of platform, shovels, hoes, wheelbarrows and other small tools.

8. Where work is so located that a mixer can be used, the capacity of ½ yard will best serve.

9. I would not consider a job of 200 yds. large enough to justify a mixer, except under favorable conditions, such as within yard limits, or a season's program large enough to justify setting up an outfit on cars, or placing it on the job. Ordinarily, these conditions would not prevail on a job of less than 200 yds., outside of yard limits, and the result would be greater economy by hand mixing, as the increase in cost of handling would be more than offset by the saving of cost of unloading, setting up, and loading the mixer for such a short job.

10. Undoubtedly, on many small jobs gasoline pumps would be of advantage, but it has been my practice to perform such small jobs, when possible, during the dry season, when bailing or pumping by hand pumps was sufficient. Where large volumes of water are met in large

jobs, I have obtained the best results from steam operated pulsometers.

11. My work has not compelled me to use unit construction, but I would most certainly employ it at congested points under heavy traffic.

12. Have done all possible to encourage the use of unit forms for standard culvert construction, in order to reduce the cost of construction, and increase the number constructed each year.

13. For small jobs 2x8—16 is a convenient size.

14. This has not been developed to the desired point, but some progress has been made. The trouble is rather one of organizing and forms than of help, as the additional work necessary for computing actual costs is very small compared with the records actually made.

15. Nothing has yet been done along this line.

16. Blank.

17. I believe the most important suggestion is to increase the amount of small concrete jobs, which can be done by working thru a well defined program, and coöperating closely with the engineering department to ascertain which trestles and other small structures can be most economically rebuilt by concrete.

Reply of W. H. Courtenay, chief engineer, Louisville & Nashville:—

1. Work of this sort is ordinarily done by company force, excepting at such times as such forces may not be available or there is some particular advantage in letting to contract.

2. Such work is ordinarily done by division forces under the general authority of the division superintendent.

3. A gang for this work would consist of a foreman and such number of skilled workmen and laborers as could be economically worked. Foremen are paid in the neighborhood of $80 per month and skilled laborers at the prevailing rates.

4. Work is ordinarily done to follow some predetermined plan, although occasionally special gangs are organized.

5. Cement and reinforcement are ordinarily provided thru the purchasing department; other material and aggregates obtained locally.

6. Work train service as may be necessary is handled by division officials. The average cost of concrete in place varies greatly with the nature of the work. I should say that $5 to $20 per cu. yd. would cover the extremes.

7. Suitable tools are provided, depending on the nature of the work.

8. About ½-yd. mixers are ordinarily used.

9. We prefer to use a mixer in all cases where practicable, even though its use may not be entirely justified financially.

10. Special appliances are not ordinarily employed.

11. We have not used unit construction excepting for slab bridges.

12. Unit forms are used on culvert work.

13. Foremen and supervisors ordinarily keep a close account of the cost of work and can compare cost of work done by different gangs.

15. Reply to 14th above covers this.

16. None.

17. None.

18. None.

Reply of A. Montzheimer, chief engineer, Elgin, Joliet & Eastern:—

1. We handle this class of work with our own forces.

2. Work of this character is handled by the chief engineer's office under the direction of the superintendent of bridges and buildings.

3. Each gang as a rule consists of a foreman, three form builders and three laborers. This gang, of course, is increased when necessity demands.

4. We carry this class of work on largely in accordance with a prearranged program, but occasionally there are exceptions to the program as laid out.

5. We have very good facilities for the purchase of sand and gravel for concrete, and have never operated a pit of our own.

6. Work trains are run, distributing material to various jobs and placing concrete mixers, etc. When work train is ordered out enough work is generally lined up to keep the train busy for the day. This work train is always sent out in charge of a foreman from the bridge and building department. Concrete of this character placed outside of yard limits costs from $5 to $8 per cu. yd.

7. Outfit usually consists of concrete mixer, cement storage house, form lumber, shovels and miscellaneous tools.

8. In class of work referred to we find ½ to ¾-yard mixer answers the purpose best.

9. Consider a mixer justifiable on any job that runs from 10 to 15 cu. yd.

10. In some cases we find it economical to use a gasoline pump for removing water, and in many other cases we simply use a hand sewer pump.

11. We have had no experience with unit construction on bridge work, but believe that there is some economy in handling work in this manner, especially in the construction of new work where traffic would not interfere.

12. We use unit forms wherever possible on any kind of work, and believe that they are economical wherever they can be used.

13. Form lumber for small jobs usually consists of 2x4, 2x8 and 1x6 in. material. Where foundation forms are required 2x8 size is usually used.

14. Daily reports are sent in by each crew, showing the amount and class of work done each day; also material and labor used on each class of work.

15. Up to date we have not tried competition between different crews. Each foreman, however, by the use of the daily reports that he makes out for chief engineer's office, is able to tell exactly what each piece of work is costing.

16. We use locomotive crane for handling all materials and plant for this class of work, and believe that this materially reduces the cost of labor on same.

17. As a rule, current railway practice on small jobs of concrete work could be improved by the use of more clerical work and engineering office work, in making out bills of material, to be used, keeping costs on labor and material actually used.

18. Nothing to report on this.

Reply of J. G. Gwyn, chief engineer, Denver & Rio Grande:—

1. Company forces, convenience and economy.

2. Work done by bridge gangs for all jobs enumerated, except overhead crossings when we would use a concrete foreman and gang.

3. Foreman carpenter $100, 6 carpenters $2.85, 4 helpers $2.10, foreman mason $125, 2 carpenters $2.85, laborers $2.

4. Generally, floating gangs.

5. Material furnished for each job from points on the line. Very little material local to the job used.

6. Work train furnished when asked for, but local generally answers for small jobs. Cost $8 per yd.

8. Hand work. Yard mixers for larger jobs.

9. 250 yd.

10. Nothing but hand trench pumps for smaller jobs.

11. The only units we have built at central point are for small culvert pipe.

12. We have in successful use unit forms for building in place culvert pipes from 24 in. to 36 in. and find that we can produce cheaper and better reinforced pipes than with pipe made at a central point.

13. Two-inch surfaced plank.

14. Comparing the cost of the job with others, divided by cubic yards.

15. Very little.

17. Reforming of the management so as to be allowed to keep one gang on the work.

18. On one job of new construction 7 miles in length we had upwards of 80 openings mostly pipes from 16 in. to 36 in. We established a small central yard on the work where we made 16 in., 20 in. and 24 in. pipe in units, 3 ft. long, with arch top and flat bottom with square ends, and having spiral and longitudinal reinforcement; longitudinal reinforcement having loops for wiring joints together. As pipes larger than 24 in. were too heavy to handle readily we made 30 in. and 36 in. in the trench with special unit forms, arranged so that reinforcement of bent ½ in. merchant bars could be properly placed without tying. As we were not working on an operated line no trouble was experienced on account of maintaining traffic, and the work was done at a remarkably low price and was uniformly successful, although many of the openings were so-called syphons, for irrigation service, some under considerable hydraulic head. Many small devices of a simple nature were resorted to for cheapening the operations of making and placing the work.

Reply of C. H. Cartlidge, late bridge engineer, Chicago, Burlington & Quincy:—

1. We build such work with our own forces.

2. Our work is done by division forces. We have, however, about 25 floating gangs under the supervision of the bridge engineer, who are sent to the divisions having too much work for their own forces. While on any division, these floating gangs report to the division superintendent the same as his own men. They are under the superintendent and also a general foreman who reports to the bridge engineer.

3. These foremen receive about $85 per month. A 12-man gang would consist of three carpenters at 27½c per hour, four helpers at 23 to 25c per hour, and five laborers at 17½ to 20c per hour.

4. We carry on the work according to the predetermined program, shifting the floating gangs to the divisions having the greater amount of work.

5. Material is ordered thru the store department and filled by them from the nearest available stock. Local aggregates are hardly ever used. Most of our gravel comes from our own gravel pits.

6. Work train service is handled by local freight wherever possible, but a special work train is used in case there is a full day's work.

7. The usual outfit of shovels, wheelbarrows, etc., is used.

8. We find a ⅓-cu. yd. concrete mixer satisfactory for this work.

9. Would consider 100 cu. yd. job the minimum for ⅓ cu. yd. mixer. Expect to buy some small mixers weighing about 2,000 lbs., to try out on smaller work next year.

10. Have not been using any special appliances such as gasoline pumps on smaller jobs. Have been using Edson pumps.

11. Have been using unit construction for slabs on concrete pile trestles, and decks for deck girder bridges, for concrete pipe, concrete piling, concrete curbing, concrete water troughs, concrete signal foundation blocks and concrete fence posts.

12. We use unit forms in construction of the items mentioned in paragraph 11 only.

13. Use 2 in. lagging dressed to 1¾ in. for form lumber.

14. Blank.

15. We are able to secure competition with different gangs in a few cases only. The foremen are not advised the cost of the work.

Reply of O. F. Dalstrom, engineer of bridges, Chicago & Northwestern:—

1. Usually with railway company's forces. By contract when the work can be included in a larger general contract, such as the contract for bridge work on a whole division, or when a contractor has a plant working conveniently near the work and can handle it to advantage.

2. When work is done by railway company's forces, it is handled by the division bridge and building department. The foreman of the crew receives his instructions from the general foreman of bridges and buildings, who reports to the division engineer.

3. The crew consists of the following, varying in number of carpenters and helpers according to size of job:

1 foreman, $95.00 per month.
1 asst. foreman, 30c to 35c per hour.
1 or 2 carpenters, 27½c to 40c per hour.
6 to 10 helpers, 20c to 27½c per hour.

These rates vary with locality; also with the time of service and experience of the men.

4. The work is usually carried out as the crew reaches it. In case of a rush job, the nearest available crew is taken and put on the job. It is hardly ever practicable to make up a program at the beginning of the season and follow it thru. It is seldom found necessary, however, to have floating gangs to handle this work.

5. Sand and crushed stone are purchased, ready graded as required in the work. In just a few cases the railway company's pits supply gravel that can be screened and used for the aggregate.

6. Practically all small jobs are within yard limits and require no train service, the cars being spotted on the ground on the siding nearest the work. In the cases where the work is beyond yard limits, material is usually unloaded from way freight train.

Work trains, when required, are handled by division train crews, who report to the division dispatcher.

Mass concrete in this kind of work is estimated at $8 per cu. yd. under ordinary conditions.

7. Mixing board, wheelbarrows, shovels, hoes and slicing tools. Carpenters provided with the necessary tools for making forms.

8. The C. & N. W. Ry. has had no mixer for small work till one was purchased this year. This is a ¼-yd. mixer, which was assumed to be the capacity best adapted to the division's requirements.

9. On isolated jobs a mixer would probably not be justified if there is less than 50 cu. yds. of concrete to be mixed.

10. Hand operated diaphragm pump or gasoline centrifugal pump is used, the kind of pump depending on the amount of water that must be handled.

11. Practically all concrete work that is done by railway company's forces is built in place. Slabs for decks of bridges, and for replacing short steel spans on old masonry, are built by contractors; these are usually built at a central point and shipped to the bridge.

12. Contractors use unit forms in the work mentioned in No. 11.

13. 1x4 in. and 2x6 in. for the surface lumber, and 4x6 in. for posts and bracing.

14. The cost of the labor can be taken from the time books. The division accountant can furnish the total cost after a job is finished, for comparison with the estimated cost.

15. No competition on small work. The foreman is not kept advised of the cost of the work, but he can obtain it from division records, thru the general foreman, if desired.

16. Blank.

17. More improved equipment in the way of power operated pumps and mixers. Hiring efficient foremen, and making the position of foreman worth while for a capable man.

Reply of W. F. Steffens, special engineer, New York Central:—

1. Small jobs are invariably handled by railroad company forces, as better work is accomplished than by contract.

2. Divisional forces are used for such work. The gang is visited every few days by the supervisor or his assistant.

3. Ordinary group consists of a foreman, carpenter form builder, 2 drillers or helpers, and about 15 mason helpers.

4. Ordinary work is handled by regular forces. Occasionally additional forces are necessarily assembled to handle special work—as such arises.

5. Practically all materials such as gravel, sand and cement are handled by work trains to the site, although all lumber and some cement may be handled by local freight trains.

6. A regular work train on the division handles the work of the department in general.

Unit prices average about as follows:

Class	1:2:4	$ 9	per yd.
"	1:3:6	6	" "
"	1:1:2	12	" "
"	1:4:7½	5	" "

This, of course, being very approximate, inasmuch as on some work these prices may be modified very considerably in either direction. For example—if local deposits of gravel or sand are available as taken from foundation excavation, the unit cost of the concrete work would be very materially reduced. It seems undesirable to place this sort of information in committee reports, except as they might appear in general for a large number of railroads on account of the wide fluctuations possible, as mentioned.

7. For this work we find a concrete mixer desirable, and have used successfully with such a kerosene engine, altho several mixers are equipped with gasoline engines.

8. One yard capacity mixer has been found a desirable size.

9. We use mixers on jobs of 200 yds. or over.

10. Hand diaphragm pumps are used where not much water is encountered. For other work centrifugal pumps varying in sizes from 6 to 10 in. are indicated.

11. Our preference has been for concrete work built direct at the site rather than at some central yard. This, however, is a matter that would be governed entirely by local conditions. It is conceivable that for certain class of work, much greater economy and efficiency could be secured by constructing units at a central point.

12. On such work as is usually handled by the forces mentioned, little use has been found for unit forms, except on small pier foundations, signal bridges, at turntable pits and building foundations.

13. Lumber for this work: 2 x 4 in. for studding, 1 x 8 in. S1S, tongued and grooved for face work and 1 x 10 in. hemlock for back forms.

14-15. Information regarding cost of work is kept in office. Those directing the work locally are subsequently informed as to relative cost with the object of encouraging the foreman and improving efficiency.

16. For the average work around railroads, special devices are seldom indicated. The conditions are quite different at most work of this sort than found by building contractors where special equipment of elevators and chutes is so frequently used.

17. No comments.
18. No comments.

Reply of F. E. Schall, bridge engineer, Lehigh Valley:—

1. Generally by our division forces, except on new construction, when the work is included in the general contract.
2. Division organization (we have no department forces except contractors' forces, which are controlled from the chief engineer's office.) The division work is in general charge of the division engineer, to whom the supervisor of bridges and buildings, who has direct charge of the work, reports; the supervisor of bridges and buildings has one or two general foremeh and each has a number of gang foremen.
3. Usually a gang foreman and 6 to 8 men, depending on the size of the job. In many cases the carpenters who make the forms assist in the mixing and placing of concrete; the excavation, however, is done with common labor.

Rates paid, foreman,	\$3.00 to \$3.50
Carpenters,	3.00
Laborers,	1.85

4. Generally the work is carried on according to a pre-determined program established from month to month, using the regular division forces, supplemented by extra men whenever desirable or called for by the sizes of the job or the conditions found. Floating gangs are not employed, except in special cases this method might be adopted fully equipping a gang and sending them from job to job.
5. The material is usually distributed by a work train for a number of jobs on the same trip; local aggregates are used if found in satisfactory condition; for important work the sand and gravel aggregates are separated and the gravel washed if found necessary to secure the best results.
6. The cost of the work train is distributed according to the time spent at each job. The average cost per cu. yd. of concrete in place varies with the general dimensions of the concrete, the size of the job and the mixture required; no fixed amount can be established but for small jobs in general railroad work will run from \$5.50 to \$8 per cu. yd.
7. Concrete mixer, screens. wheelbarrows, shovels, spades, water barrels, buckets and small gasoline pump.
8. One half to ¾ cu. yd. small Ransome batch mixer.
9. This depends upon the kind of mixer used; if a gasoline batch mixer is used 30 cu. yds. upward should warrant the use of a mixer; for the larger steam drivers a job should be 100 or more cu. yds. to warrant the expense of setting up a mixer; if the outfit is mounted on a car and a side track near the job, a mixer could be economically employed for less than 100 cu. yds.
10. When pumping is required we employ hand pumps, Jack of all Trade 2 h. p. gasoline direct connected Fairbanks-Morse pump, and centrifugal steam driven pumps where larger volumes of water must be handled.
11. For reinforced concrete slabs used in spanning small openings say up to 25 ft. we have built the slabs at a central point, under contract, and after seasoning have the division forces erect them in place.
12. No.
13. For shoring foundations we use 2 in. and 3 in. planking and from 6 x 6 in. to 8 x 8 in. ranges and braces, depending upon pressure to be taken care of.
14. None.
15. No.

16, 17 and 18. I have nothing to offer since my duties are principally designing.

Reply of J. S. Spurway, secretary, New South Wales Gov't Rys. and Tramways:—

1. Works are carried out by our own staff.

2. Butty Gang System—one gang to average 4 men and increased according to size of particular job. Supervised by inspector.

3. Ninety per cent of jobs, 4 men and 1 ganger. Wages, ganger 13 S. per day and men 9 S. /9d. per day, (this including 1 S /Od. expenses).

4. In all cases floating gangs are used, as the work is intermittent and scattered over a large area of country.

5. Material is provided from central depot in all cases. Local aggregate does not exist.

6. Material is worked out to mileage generally on local trains and special arrangements made to stop, say 20 min. to unload, say 3 trucks at a time. Average cost per cu. yd. 35 S. /Od.

7. Practically all hand work done, gang using portable banker board generally of 6 x 2½ in. hardwood in 16 ft. lengths laid on sand. Water in dry districts is provided by train, and ordinary No. 5 sq. mouth shovels used, iron shod rammer and spade for facing work.

8. Power mixers are not used.

9. For small jobs would advocate small continuous mixer, "Eureka" principle,—gear driven by hand (one man).

10. Power mixers are used only on the larger jobs. "Eureka."

11. Photographs herewith will serve to illustrate works done at a central point. No. 1 is a station nameboard, No. 2 a corbel, No. 3 a stand for water tank. Note, there would be no difficulty in casting the square tank itself. No. 4 shows mould, reinforcing and cast; No. 5 a loading bank constructed, using old 71½ lb. rails and reinforced concrete sheeting. This design can be taken down at any subsequent time and re-erected at practically cost of labor only. No. 6 shows a similar wall for stock trucking yards, Nos. 9, 10 and 11 show lamp posts in general use and others such as coal bins for station use and surface drains, etc., are made most economically at central points. No. 7 shows type of small job where bottom of piles has rotted off at the ground line and concrete foundations introduced. No. 8 is a view of different class of work—coal hopper in course of construction. This class of work done by hand costs 35 S. /Od. per cu. yd. (Only 5 photos reproduced.)

12. Timber forms are used for work above ground as illustrated in photos 7 and 8.

13. For work such as shown in photos 7 and 8 planking in box form full length of anything 8 x 3 in. to 12 x 3 in. dressed. After job is finished this planking can be cut and used up to prevent undue waste. In large jobs, tongued and grooved boarding with stiffeners is more useful.

14. Every opportunity, as the gangs are under direct control of the inspector and work checked by him.

15. Can not be done as general rule, as work varies too much.

16 and 17. General experience shows that the main thing is to lay out the job so as to minimize waste of time handling material.

18. See photographs referred to in No. 11.

1. Concrete Station Name Board, New Zealand Govt. Rys.

5. Loading Bank, New Zealand Govt. Rys., Constructed of Steel Rails and Reinforced Concrete Slabs.

6. Stock Yards Bank, Similar to No. 5. New Zealand Govt. Rys.

Nos 10 and 11. Concrete Lamp Posts, New Zealand Govt. Railways.

DISCUSSION.

(Subject No. 10, Economical Handling of Concrete on Smaller Jobs.)

L. D. Hadwen:—We have not heard from Mr. Wood. You will remember, two years ago, he showed us some concrete jobs on our trip to the coast, and we hoped that he would give us more in formation with respect to them as bearing on the subject. He has been promoted recently, and I presume has not had time to give us more information.

C. E. Smith:—There is one feature of the report that I would like to refer to in detail, and that is the relative advantages of doing small concrete jobs by company forces and by contract. About eight years ago, when I took up my work on the Missouri Pacific—Iron Mountain System—it was the practice to contract every job, no matter how small. The result is that 18 divisions of that system, a little over 7,000 miles, were not equipped to handle concrete work and timber was used for everything. The Iron Mountain end of the Missouri Pacific System ran through timber country, and that again contributed to the use of timber and the absence of concrete construction. After I studied it a year or two I became disgusted with the doing of small concrete jobs by contractors and using so much timber in places where concrete could go and give better satisfaction, and I started in to get our division officials, supervisors and bridge foremen, interested in handling their own concrete construction. We did that by organizing concrete gangs out of St. Louis. As fast as organized I turned them over to the divisions for concrete construction, and they did the work better than we had it done before. They did it by reason of proper organization, equipment and materials. I worked with the officials of the railroad to get the various divisions the equipment they needed in the way of cranes, concrete mixers, and so forth, when necessary, and I got authority from the management, as time went on, to pay proper salaries for concrete foremen. In 1908 or 1909 we started doing considerable of our large concrete jobs, and soon we took over all of our concrete work, including our bridge foundations, and in 1912 our bridge erection. From 1912 to 1915, when I left the company, there had not been a bridge contract let. The bridge foremen and superintendents had done all our bridge work. There was immediately a flood of requests for concrete work never before thought of. We were able to launch forth a program of concrete construction. Instead of

blindly renewing our timber bridges we embarked on a campaign of filling the bridges; during 1911 to 1915, we filled 25 miles of timber bridges, cleaned up an average of five miles a year, and I attribute that to the fact that we encouraged concrete construction by company forces.

In 1912 we had a bad grade crossing at St. Louis, on the Frisco and the Missouri Pacific. I brought in some of the company gangs and handled our work entirely by company forces. The work was estimated at approximately the same amount, that is $300,000 for each company, but it cost the Missouri Pacific $275,000 and the Frisco $325,000. I believe it is going to be the future policy of the Frisco to do all the work of that nature that can be done by company forces.

The President:—Has anyone anything to say or add to the paper in regard to handling small jobs? I don't imagine anyone has yet found any way of putting it in except a little at a time, outside of sleight-of-hand methods. If anyone has had any experience that would be of value we would be glad to hear from him.

L. D. Hadwen:—One point I did not mention that tends to promote economy on these small jobs is shipping out your re-inforcing material, ready bent, ready for erection. This cannot always be done, but oftentimes if you have a central yard and have your cutting and bending of re-inforcing done there, you will save money. When you have to bend the bars on individual jobs, it means setting up some form of bending plant. We have just completed at Tomah, Wis., the installation of power bending machinery and intend to do all the bending in that district at that plant instead of having individual crews bend the bars on the job. If. Mr. Richards, the superintendent of that plant, were here, I would ask him to give you some information about it.

Mr. Howson:—Following out the statement Mr. Smith made a moment ago by comparison between two railroads at St. Louis, I wish to say that the general management of the other railroad which handled the work by contract, told me that he spent $15,000 this year for concrete mixing equipment for company forces, and probably will spend the same amount next year. They are going to do all the work possible by company forces.

Subject No. 11.

SMALL COALING STATIONS.

REPORT OF COMMITTEE.

An investigation of the small coaling stations in service on the different railroads throughout the country will show that many different types are used. For stations where less than 100 tons of coal is handled per day no one type of plant stands out as more efficient and better than the others. Some of the plants in service where the consumption is small are admittedly inefficient and expensive to operate; nevertheless, their use is continued because the consumption does not warrant the installation of a modern plant at high cost, and entirely efficient small plants are not available. In some instances the so-called modern mechanical plants have been discarded.

There are certain general features of small coaling stations which are objectionable and which should be given careful consideration before any particular type of plant is installed. Some types of small plants require a trestle immediately over the coaling track at such a height as to just clear a high car. This condition is dangerous and objectionable, especially if the coaling is done on the main line. If that part directly over the tracks is of steel, the maintenance will be high, and the metal will be eaten away rapidly by the gases from locomotive stacks. If the overhead structure is of wood there is danger from fire, and also the trouble from the wood decaying quickly on account of the moisture from the exhaust steam.

The use of long tracks to serve coaling stations is to be avoided wherever possible. The first cost for track construction is considerable and there is always a large amount of maintenance in connection with any track which is used continuously. One should therefore select a type of coaling station which requires the minimum amount of trackage.

With a timber structure there are always heavy maintenance charges when it gets old, and the fire risk must also be considered. It is a serious matter to lose a coaling station by fire, even though it is a small one, for, owing to the location and the trains served, a small station may be just as important to the operation of a railroad as a larger one.

The tables shown in Figs. 9 and 10 give the costs of construction, operation and maintenance of a number of coaling stations. The time required to deliver a ton of coal to the engine, and also the lineal feet of track to serve the plant are also shown in most cases. By comparing the amounts shown in these tables it will be noted that there is a wide variation, due to the varying conditions at the different plants. For instance, if a coaling station is only two or three years old the maintenance is very light, unless, of course, the rebuilding of the plant is anticipated and the cost of such rebuilding is distributed over the life of the plant as a maintenance charge. The figures for operation will vary considerably on account of the class of labor available in any particular locality. The kind of coal and the style of equipment in which it is furnished also enter largely into the cost of operating a plant. As regards the cost of construction, the same type of plant may cost much more at one place than at another. It is possible that the foundation work may be more difficult at one point than another, thereby greatly increas-

ing the cost of the plant, while the topography of the ground may be such as to require extensive track construction.

Fig. 1 shows an air-hoist bucket plant such as is used on the Minneapolis & St. Louis, and with perhaps some modifications on many other western roads for small stations. The trackage necessary is not great and the maintenance of such a plant is not high when the small amount of coal used is considered. It will be noted that the frame supporting the hoist is built over the coaling track. Some of the railroads use an air hoist having a derrick which swings out over the coaling track and avoids putting an obstruction over the coaling track. The derrick type of air hoist used on the Soo Line is shown in Fig. 11.

A number of stations on the Southern consist of a high platform built alongside the coaling track at the proper height to permit shoveling coal from the platform to the engine. Above this platform and farther back from the coaling track is an elevated trestle up which cars of coal are pushed on a five per cent grade, and from which the coal is dumped onto the platform. The cost of such a coaling station naturally varies, depending upon the size of the platform and the amount of track necessary to serve the plant. The cost of operation is high on account of the large amount of labor required in moving the coal. The cost of maintenance is also fairly high because so much timber is used in the construction.

A standard type of small coaling station used on the Nashville, Chattanooga & St. Louis is shown in Fig. 3. In the construction of such a plant a location should be selected where the main track is in a cut and where it is possible to locate a spur track on the top of the cut at the proper distance away from the coaling track. The cars of coal are pushed up onto the high track and the coal is then shoveled out into small narrow-gage cars which are pushed out to position over the engine to be coaled, and dumped. The cost of such a plant depends largely upon securing a location where the topography of the ground is favorable. The cost of operation is a little high on account of the labor necessary to handle the coal. If the plant can be located where it is not necessary to build a long track on a trestle part of the way, the maintenance will be fairly low.

The Nickel Plate seems to favor the use of locomotive cranes at coaling stations, and Fig. 9 shows the cost of two plants on this road; one being a mechanical plant and the other a locomotive crane. It will be noted from the figures given that, aside from the first cost, the locomotive crane makes the better coaling station.

The Union Pacific employs mechanical plants almost exclusively, even where the consumption is small. It will be noted from the table that the mechanical plant this road uses compares favorably with other types.

On the Chicago & Alton the gravity type of coal chute is used, where the cars are taken up a high trestle and the coal is dumped by gravity into bins, and thence by gravity on to the engine. This type is preferred for the larger stations, but this road is using mechanical plants at less important stations, and where the space is restricted.

On the Pennsylvania Lines West practically all plants are either of the mechanical or gravity types with pockets to receive the coal from cars and then dumping by gravity on to the locomotives. These two types are used for small as well as large stations, and the costs of maintenance and operation compare favorably with those for plants on other roads.

Fig. 8 shows a small coaling station used on the Western Maryland, in which the loaded cars are pushed up an inclined trestle to the proper height above the coaling track. The coal is dumped from cars about 8 ft. or 10 ft. onto the platform and is then shoveled into small narrow gage cars. These cars are then pushed out over a locomotive standing on the coaling track and dumped. This is another type of plant where the topography must be favorable in order to get the cheapest installation. It

has the objectionable feature of an obstruction over the main track. The operation is a little high but the maintenance is about normal. If the topography of the ground makes it necessary to construct a high trestle or an extensive platform the cost of construction as well as of maintenance will be high.

On the Baltimore & Ohio practically every type of coaling station is used, with the mechanical plant and the locomotive crane favored more than the other types. It will be noted that the locomotive cranes located at Weston, Va., and Hazleton, Ohio, show the cost of operation and also of maintenance.

The Hocking Valley reports a coaling station in which a locomotive crane is used to fill elevated bins. The cost of this plant is rather high, and the operation and maintenance also appear a little high.

The Cumberland Valley reports the use of three different kinds of coaling stations. The figures show the gravity plant at Hagerstown to be quite economical.

Some of the coaling stations used on the Norfolk & Western are shown in Figs. 2, 4 and 7. All of these plants are somewhat out of the ordinary and contain features which might be used to advantage at small coaling stations. Fig. 2 represents the type of plant with which it is necessary to have a side hill in order to get an economical installation. The operating cost is very reasonable, and the maintenance a little high. Fig. 4 represents a derrick type of plant used in connection with an elevated trestle, where the movement of the engine to be coaled is utilized in operating the derrick. A good feature of this plant is that the coal is always shoveled downward, while on most of the derrick types of coaling stations it is necessary to shovel the coal up into the buckets, thereby making the work slower. The coaling station located at Brown's Tank and shown in Fig. 7 is a fairly large plant and contains facilities for coaling over three tracks, and a possible fourth track. This has the objection previously mentioned in that it is necessary to place an obstruction over the main tracks.

The Philadelphia & Reading uses practically the same type of coaling station employed by other railroads in that territory. Evidently this road has had good success in the operation of the gravity pocket type, and also the gravity platform type.

The type used on the Santa Fe for small coaling stations is shown in Fig. 6. The coal cars are pushed up onto a trestle and the coal is shoveled into pockets alongside the trestle, from which it flows by gravity to the locomotives. We are advised that the mechanical type is used for the larger plants. It will be noted that the operation and the maintenance of these plants on the Santa Fe is reasonable.

On the Chicago & North Western the gravity pockets and the air hoist-bucket types are used. The gravity-pocket type used where the consumption is small is the same as that employed on the Santa Fe and described above. For the air hoist-bucket type a derrick is erected, the coal is shoveled from cars onto a platform and then into one-half ton buckets and it is then delivered to the engine by means of the derrick; the coal being dumped by opening the bottom of the buckets. Air from the locomotive is used in operating the derrick while the engine is being coaled. The derrick is also equipped for hand operation for moving the buckets around while they are being filled. The operation of these plants is rather high on account of the labor needed; the maintenance, however, is low.

The Chicago & Eastern Illinois uses the gravity pocket type, although it also has several mechanical plants in use, but these are all large stations and do not properly come within the scope of this report. Nevertheless, we have shown the costs in Fig. 10, thinking that perhaps they might be of some use.

The derrick bucket type of coaling plant used on the Minneapolis, St. Paul & Sault Ste. Marie is shown by Fig. 11. This is very similar

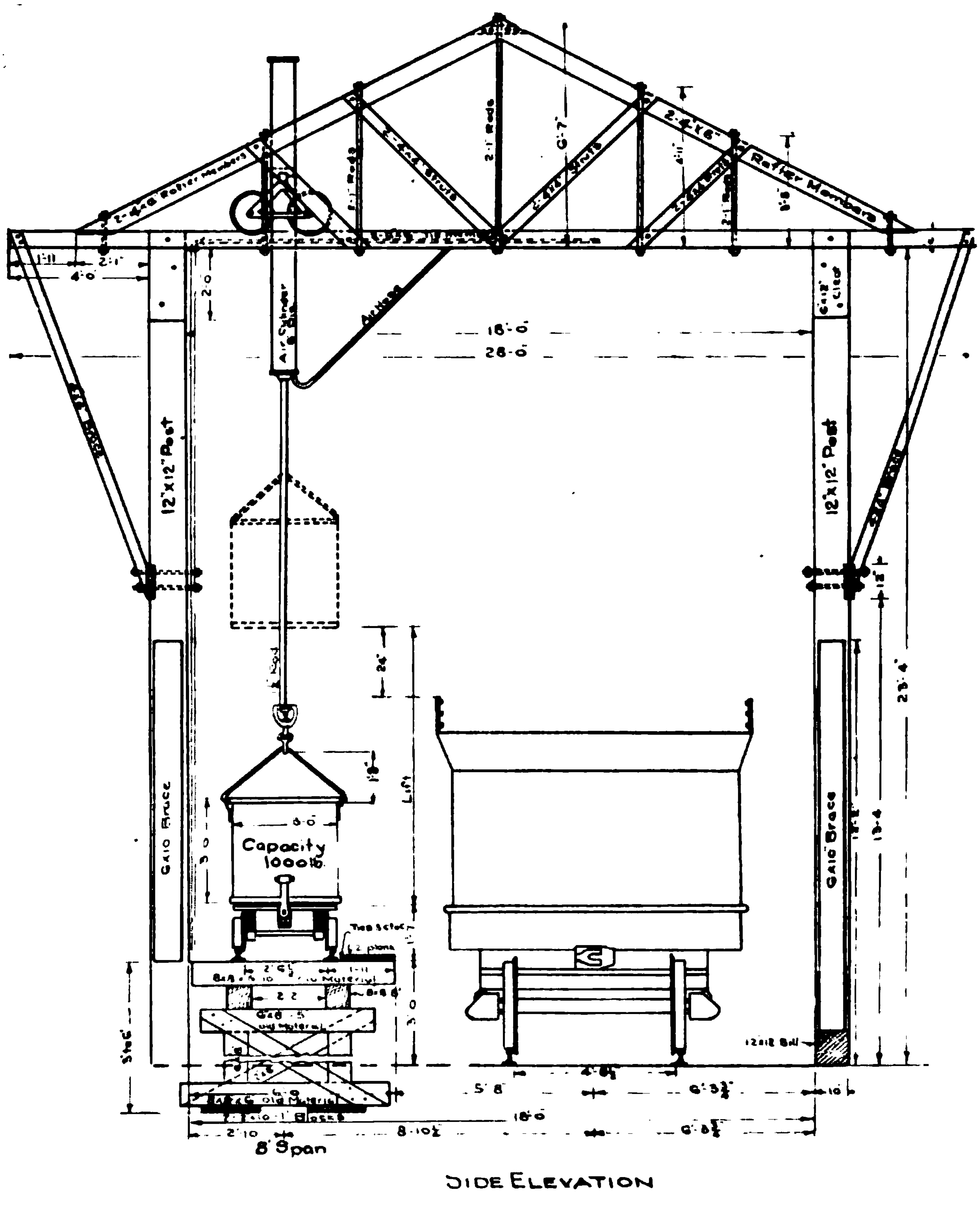
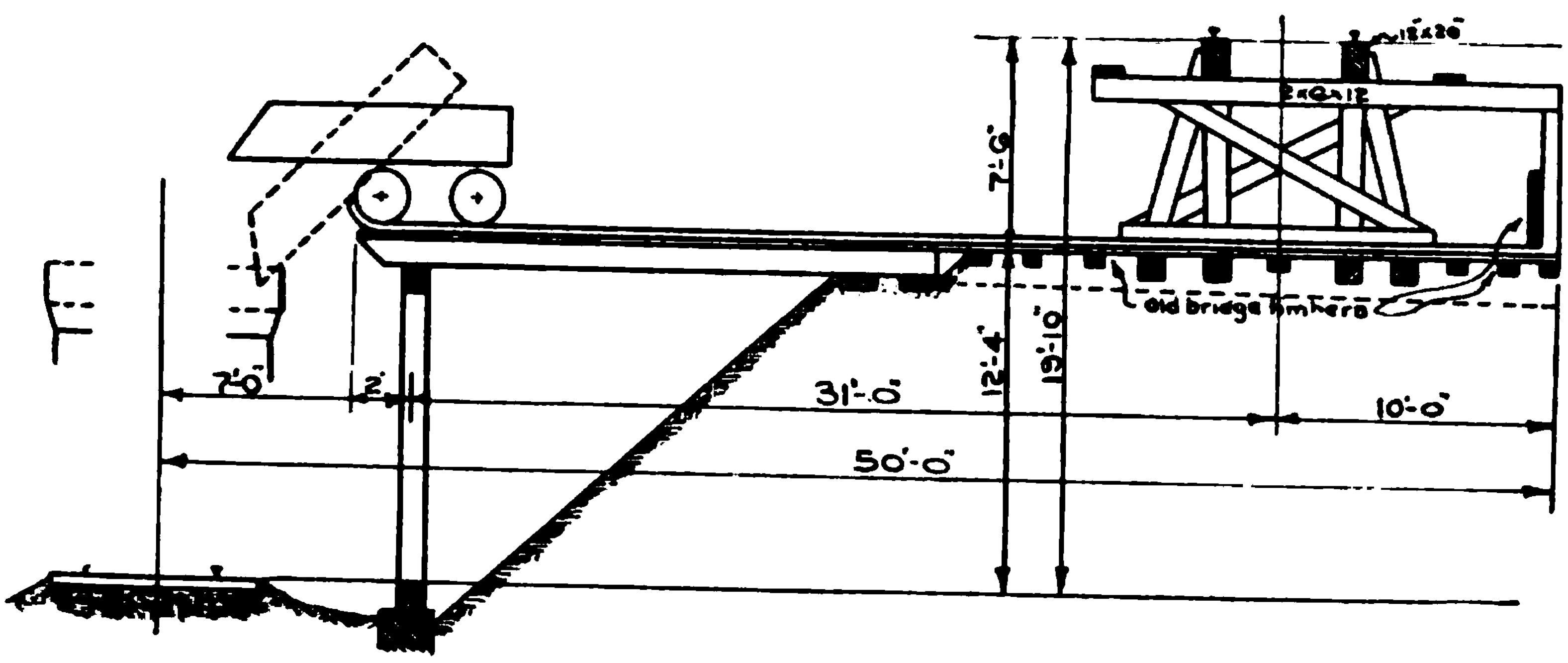


Fig. 1. Coal Chute Used on Minneapolis & St. Louis Ry.



CROSS SECTION

Fig. 2. Coal Chute Used on Norfolk & Western R. R.

to the air hoist derrick used on the North Western, and the same comments apply in that the operation is rather high.

As has been previously stated no one type seems to stand out as being particularly well adapted for use where the coal consumption is small. A coaling station where the consumption is small should be as inexpensive as possible, that is, it is preferable to have a plant in which the operation might be high rather than an expensive plant on which the operation might be comparatively low. In deciding on the construction of a coaling station the interest on the investment must be considered, and this may more than offset the higher cost of operation of a cheaper plant. Another thing to be considered is that small plants are more liable to be moved than larger ones and in selecting a type to be used this feature should be kept in mind.

Mention has been made of the growing tendency to use locomotive cranes for coaling stations. However, the cranes now in use are large machines having a capacity of from 15 to 20 tons. These cranes cost from $6,000 to $8,000, and if they are used in connection with elevated bins they result in rather expensive coaling stations. One company has worked up a design for a small crane having a capacity of 4,000 lb. at a 20-ft. radius, which will cost about $3,000. The only thing necessary to make a small coaling station in addition to this crane would be 400 ft. or 500 ft. of trackage. The labor for operating such a plant would not be more than two men, and it would undoubtedly prove to be economical both in operation and maintenance.

Committee,

L. Jutton (Chairman),
W. F. Strouse,
J. H. Nuelle,
G. W. Kinney.

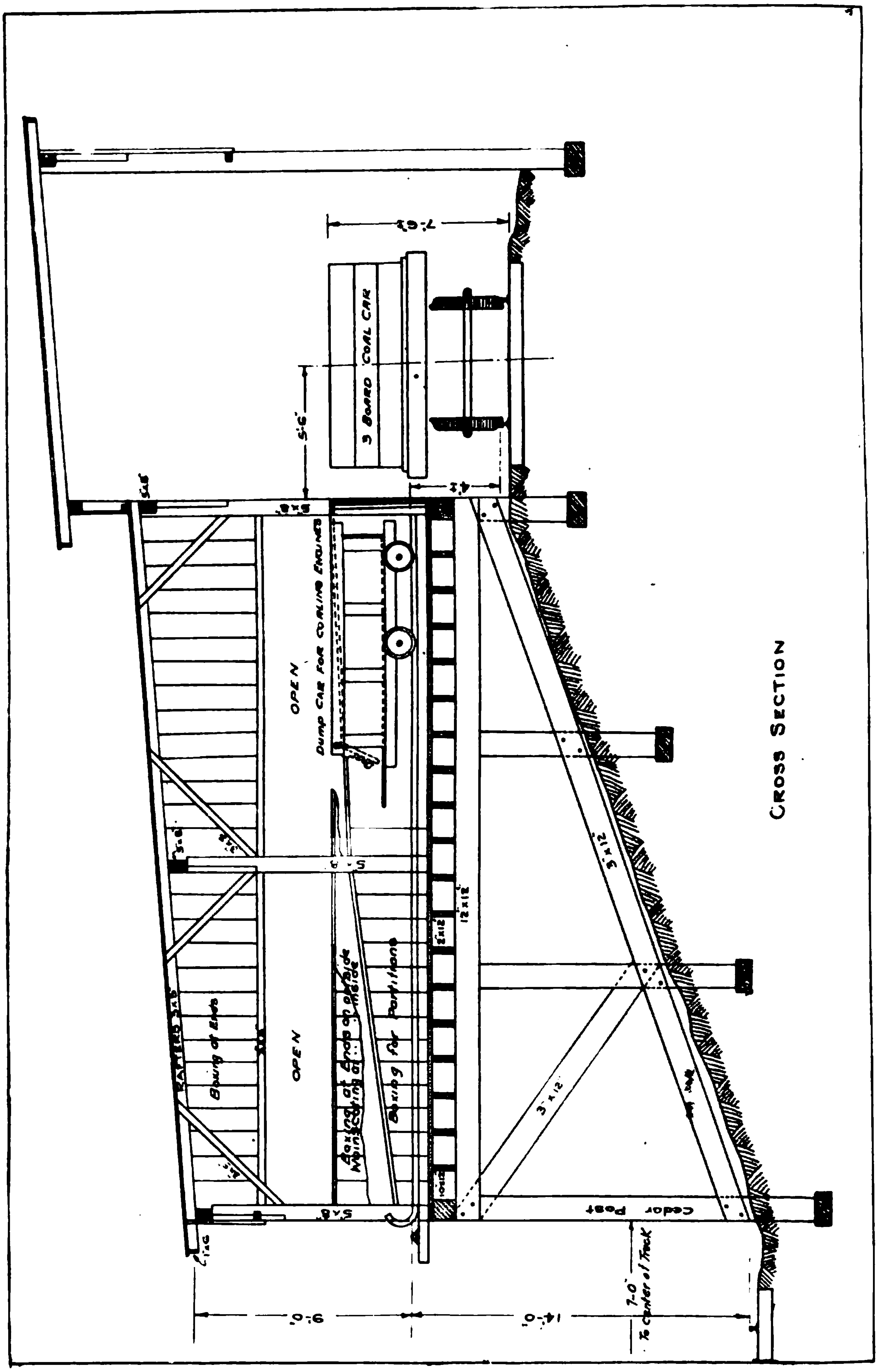


Fig. 8. Coal Chute Used on Nashville, Chattanooga & St. Louis Ry.

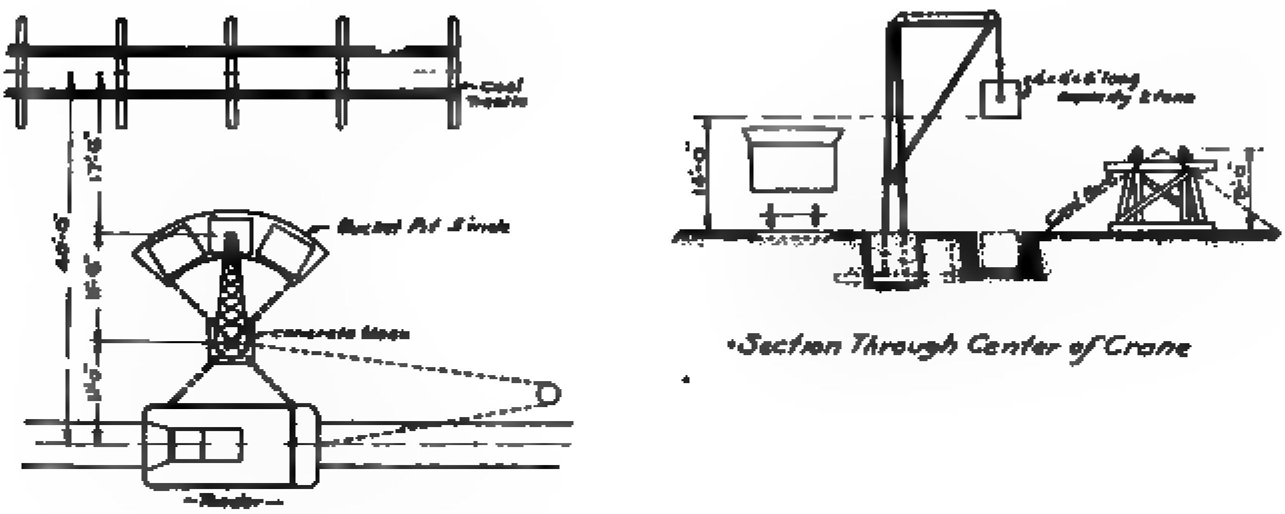
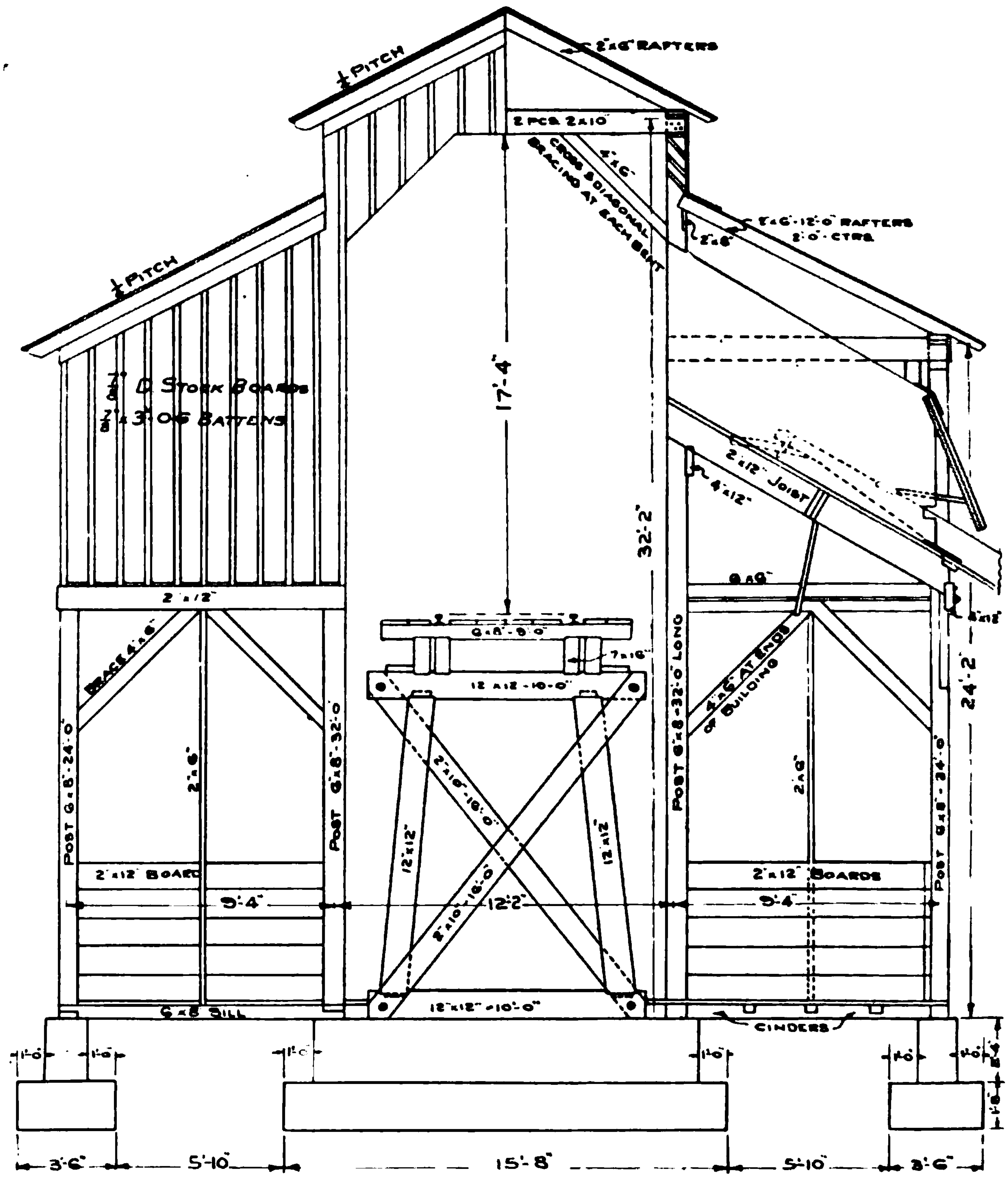


Fig 4. Coal Chute Used on Norfolk & Western R. R.

Fig. 5. Small Locomotive Crane Used for Coaling Locomotives.



HALF END ELEVATION AND TRANSVERSE SECTION

Fig. 6. Coal Chute Used on Atchison, Topeka & Santa Fe Ry.

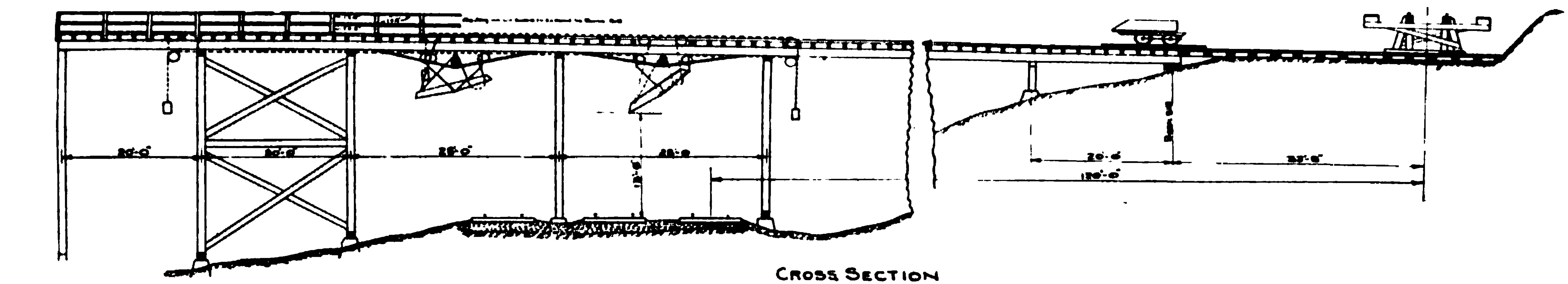


Fig. 7. Coal Chute Used on Norfolk & Western R. R.

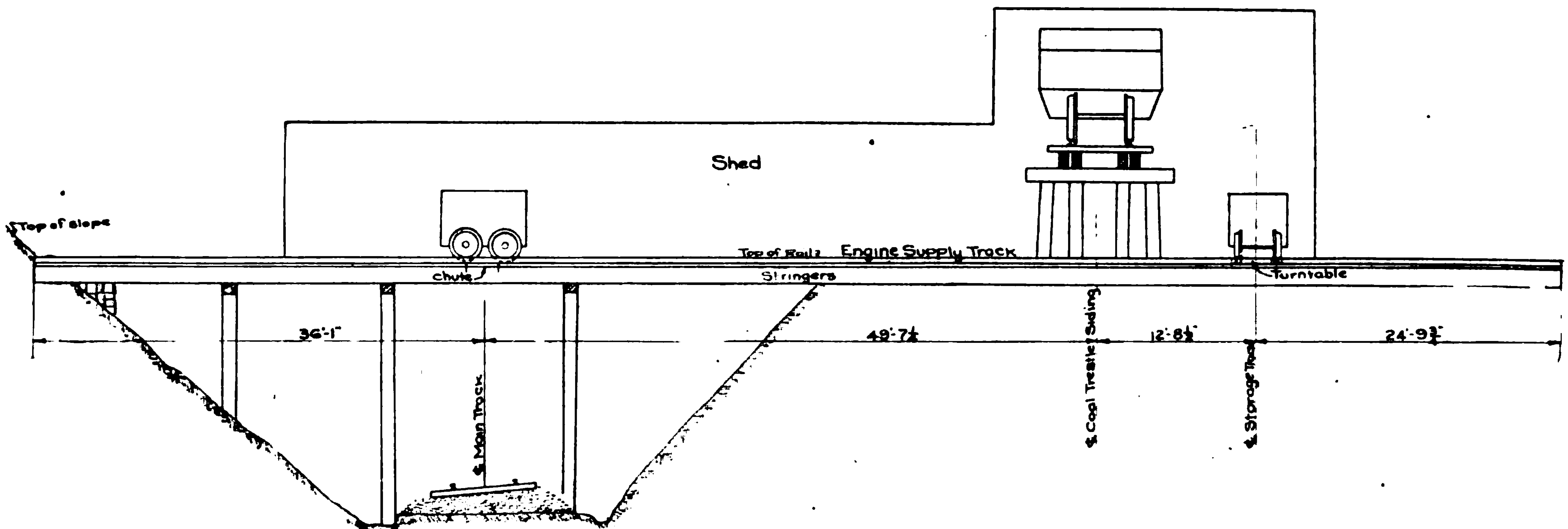


Fig. 8. Coal Chute Used on Western Maryland Ry

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION
COMMITTEE No. 11. SMALL COALING STATIONS 1916.

FIGURE 9

No	Railroad	Location	Type	Cost of Construction	Cost of Operation per Ton	Cost of Maintenance per Ton	Time to Deliver Coal per Ton	Lineal Feet of Track Required
1	M.&ST.L.R.R.	Morton, Minn.	Gravity-8 pockets	$5919	$.13	—	—	780
2	"	Watertown, So.Dak.	" 5 "	3489	.15	$.0012	—	678
3	"	Cramers, Ill.	" 8 "	7992	.027	.0023	—	1070
4	"	Tolstoy, So.Dak.	Air Hoist	622	.126	.0093	—	370
5	C.M.&ST.P.R.R.	Div. St. Chicago.	Mechanical	7600	.051	.02	.3 min.	275
6	Southern R.R.	Roder, Tenn.	Gravity-Pockets	11171	.065	.0105	.5 min.	—
7	"	Old Fort, N.C.	Gravity-Platform	2000	.037	.0238	5.0 "	279
8	"	Cumberland Gap, Tenn.	"	1019	.061	.0081	2.0 "	609
9	"	Balsam, N.C.	"	1751	.065	—	10.0 "	—
10	"	Bryson, N.C.	"	3767	.053	.0063	5.0 "	—
11	"	Stevenson, Ala.	"	2096	.115	.0225	2.5 "	—
12	"	Belle Mina, Ala.	"	1965	.16	.0233	3.0 "	—
13	"	Pocahontas, Tenn.	"	1280	.12	.0227	2.5 "	—
14	"	Strasburg Jct., Va.	"	4000	—	.03	1.0 "	—
15	"	Jetersville, Va.	"	8000	.125	.09	1.0 "	886
16	"	Lawrenceville, Va.	"	5000	.061	.07	1.0 "	580
17	"	Angelico, Va.	"	4000	.061	.04	1.0 "	836
18	"	Buffalo Jct., Va.	"	4000	.076	.045	1.0 "	814
19	"	South Tunis, N.C.	"	5000	—	.035	1.0 "	1161
20	N.C.&ST.L.R.R.	Various	Gravity-Cars	Various	.07	.02	1.0 "	Various
21	Nickel Plate R.R.	Fort Wayne, Ind.	Mechanical	9860	.053	.0102	—	—
22	"	"	Crane	11605	.044	.0071	—	—
23	Union Pacific R.R.	Various	Mechanical	8000	.04	.01	.2 "	750
24	Penna. Lines West	Youngstown, O.	Mechanical	9163	.096	.0145	.33 "	320
25	"	Erie, Penna.	Gravity	4038	.0287	—	.2 "	829
26	"	Lancaster, O.	Mechanical	7384	.023	.005	.5 "	509
27	"	Carrothers, O.	Gravity	12828	.0256	—	.2 "	1946
28	"	Cambridge, O.	Gravity	6057	.0112	.0024	.25 "	675
29	Western Maryland R.R.	Cranberry, Md.	Gravity-Cars	7500	.0909	.0121	.25 "	850

Fig. 9.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION
COMMITTEE No. II. SMALL COALING STATIONS 1916.

FIGURE 10.

No	Railroad	Location	Type	Cost of Construction	Cost of Operation per Ton	Cost of Maintenance per Ton	Time to Deliver Coal per Ton	Lineal Feet of Track Required
30	Baltimore & Ohio	North Vernon, Ind.	Mechanical	$8962	$.0374	$.0019	.2 Min.	—
31	" "	Piedmont, W. Va.	Gravity-Platform	9000	.0217	.0235	2 "	—
32	" "	Flatwood, W. Va.	Platform-Crane	2250	.16	.0019	—	—
33	" "	Hardman, W. Va.	Crane & Clam shell	6750	.13	.0280	—	—
34	" "	Weston, W. Va.	" " "	6750	.05	.0002	—	—
35	" "	Hazelton, O.	Loco. Crane & Bins	8770	.05	.0150	—	—
36	Hocking Valley R.R.	Logan, O.	" " "	10705	.09	.02	.2	500
37	Cumberland Valley	White Hill, Penna.	Mechanical	13220	.0335	.0011	.69 "	—
38	" "	Hagerstown, Md.	Gravity-Bins	6223	.024	.0094	.87 "	—
39	" "	Chambersburg, Pa.	Elec. Hoist & Cars	6791	.0635	.0011	.5 "	—
40	Norfolk & Western	Ridgeway, Va.	Gravity-Cars	2000	.045	.0407	1.0 "	750
41	" "	Petersburg, Va.	Crane-Buckets	2300	.085	.008	—	—
42	Phila. & Reading	West Milton, Pa.	Gravity-Pockets	9928	.014	.0064	—	1800
43	" "	So. Bethlehem, Pa.	Gravity-Platform	1000	.063	.0021	—	1000
44	" "	Lebanon, Pa.	Gravity-Bins	—	.044	.0044	—	1100
45	" "	Birdsboro, Pa.	Gravity-Platform	—	.025	.014	—	1100
46	A.T.&S.F. R.R.	Various	Gravity-Pockets	Various	.057	.013	—	—
47	C.&N.-W. R.R.	Dalton, Wis.	Mechanical	10500	.12	.0009	.25 "	720
48	" "	Sullivan, Wis.	Air Hoist-Buckets	1700	.179	.0018	1.0 "	530
49	" "	Rochester, Minn.	Gravity-Pockets	5000	.115	.02	.3 "	600
50	C.E.&I. R.R.	Momence, Ill.	Gravity-Pockets	5340	.08	.009	.5 "	768
51	" "	Jackson, Ind.	Gravity-Pockets	4484	.08	.014	.5 "	624
52	" "	Cypress, Ill.	Mechanical	7836	.039	.005	.5 "	443
53	" "	Lenox, Ill.	Mechanical	10057	.036	.025	.5 "	900
54	M.St.P.&S.S.M. R.R.	Chelsea, Wis.	Derrick-Buckets	—	.248	—	—	—
55	" "	Phillips, Wis.	Derrick-Buckets	—	.126	—	—	—

Fig. 10.

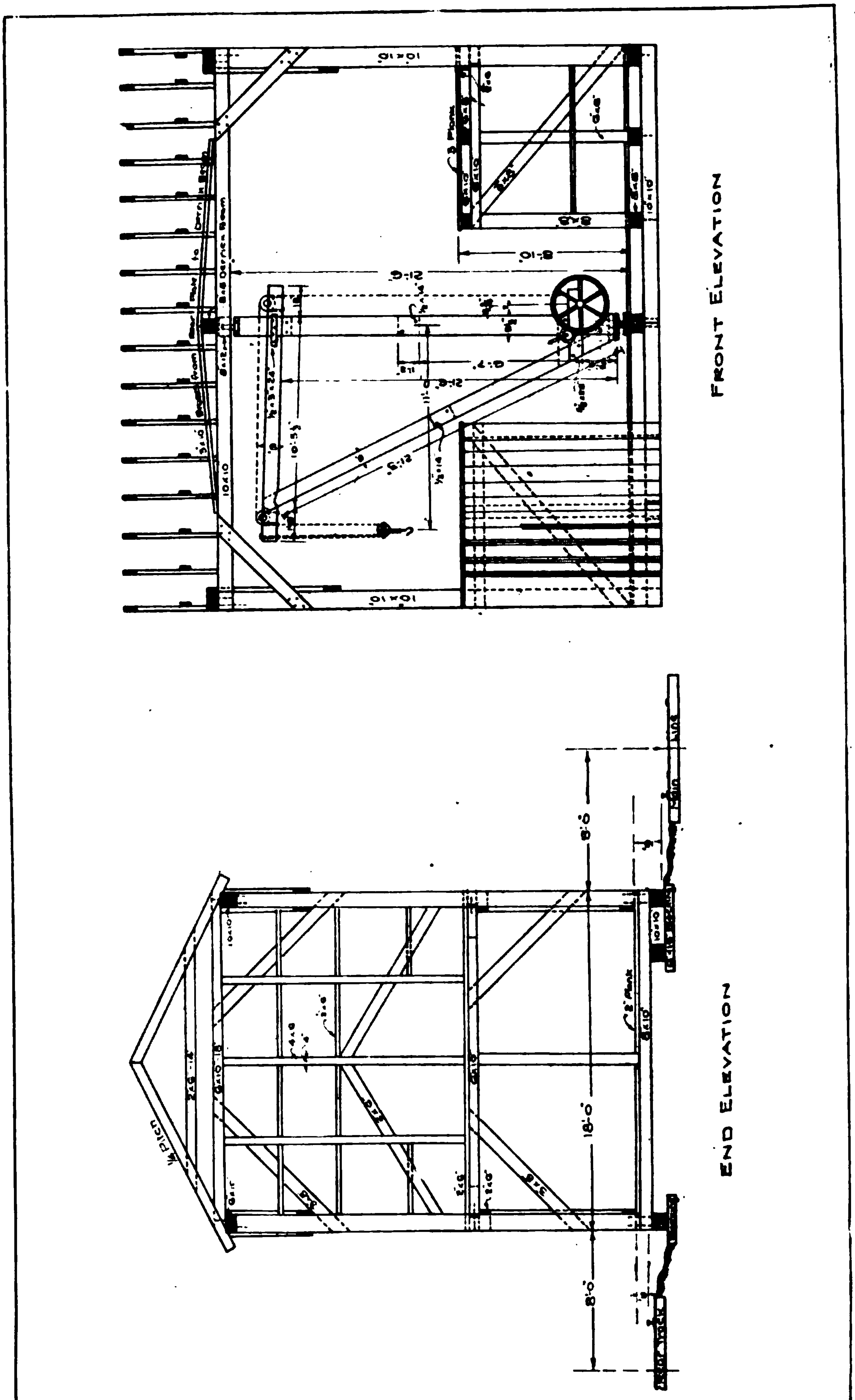


Fig. 11. Coal Chute Used on M. St. P. & S. S. M. Ry. (Soo Line).

Fig. 12. Coal Chute Used on B. & O. R. R.

Fig. 13. Coal Chute Used on B. & O. R. R.

Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Colo.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428
21	St. Louis, Mo.,	Oct. 17-19, 1911	499
22	Baltimore, Md.,	Oct. 15-17, 1912	524
23	Montreal, Que.,	Oct. 21-23, 1913	570
24	Los Angeles, Cal.,	Oct. 20-22, 1914	586
25	Detroit, Mich.,	Oct. 19-21, 1915	665
26	New Orleans, La.,	Oct. 17-19, 1916	710

	1891-2.	1892-3.	1893-4.	1894-5.
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews
1st. V.-Pres.	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle
2nd. V.-Pres.	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford
3rd. V.-Pres.	James Stannard	N. W. Thompson	L. K. Spafford	James Stannard
4th. V.-Pres.	G. W. Hinman	C. E. Fuller	E. D. Hines	Walter G. Berg
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	George M. Reid	George M. Reid	George M. Reid
Executive Members	W. R. Damon	G. W. Andrews	O. McNab	James Stannard
	G. W. Markley	J. M. Staten	A. S. Markley	James H. Travis
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	J. H. Cummin
	G. W. McGehee	O. McNab	James Stannard	R. M. Peck
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane

	1895-6.	1896-7.	1897-8.	1898-9.
President	W. A. McGonagle	James S	G. Berg	J. H. Cummin
1st. V.-Pres.	L. K. Spafford	Walter (	Cummin	A. S. Markley
2nd. V.-Pres.	James Stannard	J. H. C	Markley	C. C. Mallard
3rd. V.-Pres.	Walter G. Berg	A. S. M	Hinman	W. A. Rogers
4th. V.-Pres.	J. H. Cummin	R. M.	Mallard	J. M. Staten
Secretary	S. F. Patterson	S. F. P	atterson	S. F. Patterson
Treasurer	George M. Reid	N W.	Thompson	N. W. Thompson
Executive Members	R. M. Peck	W. O. E	Bishop	Wm. S. Danes
	J. L. White	W. M.	Austin	J. H. Markley
	A. Shane	J. M. S	ey	W. O. Eggleston
	A. S. Markley	G. J. Bi	Danes	R. L. Heflin
	W. M. Noon	C. P. A	Markley	F. W. Tanner
	J. M. Staten	M. Rine	Eggleston	A. Zimmerman

	1899-1900.	1900-1901.	1901-1902.	1902-1903.
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering
1st. V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard
2nd. V.-Pres.	J. M. Staten	B. F. Pickering	A. Shane	A. Shane
3rd. V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th. V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith
	R. L. Heflin	H. D. Cleaveland	W. E. Smith	A. W. Merrick
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichty
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston
	A. Montzheimer	A. W. Merrick	W. O. Eggleston	J. H. Markley

	1903-1904.	1904-1905.	1905-1906.	1906-1907.
President	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley
1st. V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid
2nd. V.-Pres.	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty
3rd. V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse
4th. V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	H. H. Eggleston	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt

	1907-1908.	1908-1909.	1909-1910.	1910-1911.
President	R. H. Reid	J [illegible]	J. S. Lemond	H. Rettinghouse
1st. V.-Pres.	J. P. Canty	F [illegible] use	H. Rettinghouse	F. E. Schall
2nd. V.-Pres.	H. Rettinghouse	F [illegible]	F. E. Schall	A. E. Killam
3rd. V.-Pres.	F. E. Schall	J [illegible] l	A. E. Killam	J. N. Penwell
4th. V.-Pres.	W. O. Eggleston	A [illegible] s	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S [illegible] son	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C [illegible] a	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J [illegible]	W. Beahan	T. J. Fullem
	J. S Lemond	U [illegible] an	F. B. Scheetz	G. Aldrich
	C. W. Richey	F [illegible] etz	L. D. Hadwen	P. Swenson
	T. S. Leake	W [illegible] ey	T. J. Fullem	G. W. Rear
	W. H. Finley	I [illegible] en	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T [illegible] l	P. Swenson	W. F. Steffens

	1911-1912.	1912-1913.	1913-1914.	1914-1915.
President	F. [illegible]	[illegible] E. Killam	J. N. Penwell	L. D. Hadwen
1st. V.-Pres.	A. [illegible]	[illegible] N. Penwell	L. D. Hadwen	G. Aldrich
2nd. V.-Pres.	J. [illegible]	[illegible] D. Hadwen	G. Aldrich	G. W. Rear
3rd. V.-Pres.	L. [illegible]	[illegible] J. Fullem	G. W. Rear	C. E. Smith
4th. V.-Pres.	T. [illegible]	[illegible] Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. [illegible]	[illegible] A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. [illegible]	P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. [illegible]	W. Rear	W. F. Steffens	W. F. Steffens
	P. [illegible]	[illegible] F. Steffens	E. B. Ashby	S. C. Tanner
	G. [illegible]	[illegible] B. Ashby	S. C. Tanner	Lee Jutton
	W [illegible]	[illegible] E. Smith	Lee Jutton	W. F. Strouse
	E. [illegible]	C. Tanner	W. F. Strouse	C. R. Knowles
	W [illegible]	[illegible] ee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917
President	G. W. Rear	C. E. Smith
1st. V.-Pres.	C. E. Smith	E. B. Ashby
2nd V.-Pres.	E. B. Ashby	S. C. Tanner
3rd V.-Pres.	S. C. Tanner	Lee Jutton
4th V.-Pres.	Lee Jutton	F. E. Weise
Sec.-Treas.	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse
	W. F. Strouse	C. R. Knowles
	C. R. Knowles	J. S Robinson
	J. S. Robinson	A. Ridgway
	A. Ridgway	J. P. Wood
	J. P. Wood	D. C. Zook

CONSTITUTION *

ARTICLE I.

NAME.

SECTION 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

SECTION 1. The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussions, providing a medium for the exchange of ideas to the end that bridge and building practice may be systematized and improved.

SECTION 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The membership of this association shall be divided into two classes—active and life members.

SECTION 2. To be eligible for active membership, a person must be actively employed in railway service in responsible charge of the design, construction or maintenance of railway bridges, buildings or other structures; a professor of engineering in a college or university of recognized standing; an engineering editor, or a government or private timber expert.

SECTION 3. To be eligible for life membership a person must have been a member of the association for at least five years and in general must have retired from active railway service. The association, however, may waive the latter condition by a majority vote of the members at a regular session for good and sufficient reasons. A life member shall have all the privileges of active membership and shall not be required to pay annual dues.

SECTION 4. Any member guilty of conduct unbecoming a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, may forfeit his membership on a two-thirds vote of the members present at any regular session of the association.

SECTION 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

* Revised October, 1914. Amended October, 1916.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary-treasurer and six executive members, all of whom shall constitute the executive committee.

SECTION 2. The past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECTION 3. Vacancies in any office for the unexpired term shall be filled by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial interests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECTION 2. Two-thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECTION 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association which convenes on the third Tuesday in October, and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

SECTION 2. The president, four vice-presidents and secretary-treasurer shall hold office for one year and the executive members for two years, three being elected each year. All officers will retain their offices until their successors are elected and installed.

SECTION 3. The term of office of the secretary-treasurer may be terminated at any time by a two-thirds vote of the executive committee. His compensation shall be fixed by a majority vote of the executive committee. The secretary-treasurer shall also serve as secretary of the executive committee.

SECTION 4. The secretary-treasurer shall be requir d to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

ANNUAL DUES.

SECTION 1. Every member upon joining the association shall pay to the secretary-treasurer three dollars membership fee and two dollars per year in advance for annual dues. No member one year in arrears for dues shall be entitled to vote at any election, and any member more than one year in arrears shall be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least sixty days previous to said regular meeting.

BY-LAWS*

TIME OF MEETING.

1. The regular meeting of this association shall convene annually on the third Tuesday in October at 10 a. m.

PLACE OF MEETING.

2. Places of holding the next annual convention may be proposed at any regular session of the association. All the places proposed shall be submitted to a ballot vote of the members present at the annual business session and the place receiving a majority of all votes cast shall be declared the location of the next annual meeting. If no place receives a majority of the votes cast, the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

3. It shall lie within the power of the executive committee to change the location of the meeting place if it becomes apparent that it is for the best interests of the association.

QUORUM.

4. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

DUTIES OF OFFICERS.

5. The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall,

* Revised October, 1914. Amended October, 1915.

with the secretary-treasurer, sign all contracts or other written obligations of the association which have been approved by the executive committee. At the annual meetting the president shall present a report containing a statement of the general condition of the association.

6. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

7. It shall be the duty of the secretary-treasurer to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

NOMINATING COMMITTEE.

8. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, which shall prepare a list of names of nominees for officers to be voted on at the next annual convention, in accordance with Article VI of the constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE.

9. At the first session of each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary-treasurer and certify as to the correctness of his accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

COMMITTEE ON SUBJECTS FOR DISCUSSION.

10. After the annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEES ON INVESTIGATION.

11. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE.

12. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS.

13. 1st—Registration of members.
2nd—Reading minutes of the last meeting.
3rd—Admission of new members.
4th—President's address.
5th—Report of secretary-treasurer.
6th—Payment of annual dues.
7th—Appointment of special committees.
8th—Reports of standing committees.
9th—Unfinished business.
10th—New business.
11th—Election of officers and selection of place for holding next annual meeting.
12th—Installation of officers.
13th—Adjournment.

(Report of nominating committee to be read at first session of second day—Section 9 of By-Laws.)

DECISIONS.

14. The votes of a majority of the members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

15. All discussions shall be governed by Robert's rules of order.

DIRECTORY OF MEMBERS

Aagaard, P., Chief Inspector, I. C. R. R., Chicago.
Ailes, N. C., Asst. Val. Engr., D. & H. Co., Albany, N. Y.
Airmet, E. S., For. Ptr., O. S. L. R. R., Salt Lake City.
Alexander, W. E., Supt. B. and B., B. & A. R. R., Houlton, Me.
Allard, E. E., For. B. & B., Mo. Pac. Ry., St. Louis.
Allen, T. H., Supv. B. & B., C. & O. Ry., Hinton, W. Va.
Althof, L. W., Asst. Brg. Engr., O. S. L. R. R., Pocatello, Idaho.
Anderson, August, Gen'l For. B. and B., L. S. & I. Ry., Marquette, Mich.
Anderson, L. J., For. B. and B., C. & N. W. Ry., Escanaba, Mich.
Andrews, G. W., Asst. to Eng. M. of W., B. & O. R. R., Baltimore, Md
Andrews, T. O., Gen. For. B. & B., L. E. & W. R. R., Tipton, Ind.
Archbold, H. L., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
Arey, R. J., 541 So. Cummings St., Los Angeles, Cal.
Arnold, F. J., Gen. For. B. & B., D. L. & W. R. R., Scranton, Pa.
Ashby, E. B., Chief Engr., L. V. R. R., New York City.
Ashmore, A. B., Supv. B. & B., M. L. & T. Co., Lafayette, La.
Ashton, D. H., Asst. Engr., L. A. & S. L. R. R., Salt Lake City.
Auge, E. J., Chief Carp., C. M. & St. P. Ry., Wells, Minn.
Austin, C. P., 107 Park St., Medford, Mass.

Bach, C. F., For. B. & B., C. & N. W. Ry., Belle Plaine, Iowa.
Bailey, F. W., Supt. M. of W., S. A. & A. P. Ry., Yoakum, Tex.
Bailey, S. D., M. C. R. R., Detroit, Mich.
Ball, E. E., Div. Engr., A. T. & S. F. Ry., Fresno, Cal.
Ballenger, D. A., Roadmaster, Southern Ry., Greenville. S. C.
Baluss, F. C., Engr. B. & B., D. M. & N. Ry., Duluth, Minn.
Barber, N. N., Stone & Webster Eng. Corp., Rock Island. Ill.
Barger, T. R., For. B. & B., L. & N. W. R. R., Homer, La.
Barnes, O. F., Div. Engr., Erie R. R., Jersey City, N. J.
Barrett, E. K., Supvr. B. and B., F. E. C. Ry., St. Augustine, Fla.
Barrett, J. E., Supt. of Track, B. and B., L. & H. R. Ry., Warwick, N. Y
Barry, E. J., Bldg. Insp., D. L. & W. R. R., Hoboken, N. J.
Barton, M. M., 311 No. 34th St., Philadelphia, Pa.
Bates, Onward, Civil Engineer, McCormick Bldg., Chicago.
Beahan, Willard, Asst. Engr., N. Y. C. R. R., Cleveland, Ohio.
Beal, F. D., 800 Fife Bldg., San Francisco, Cal.
Bean, C. C., Contractor, 243 Benton St., Freeport, Ill.
Beard, A. H., 705 No. 11th St., Reading, Pa.
Beckman, B. F., Engr., F. S. & W. R. R., Fort Smith, Ark.
Beeler, C. L., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
Beeson, R. W., Div. For. B. and B., C. & S. Ry., Trinidad, Colo.
Bender, Henry, For. B. & B., C. & N. W. Ry., Eagle Grove, Ia.
Benz, F. A., Div. Engr., B. R. & P. Ry., E. Salamanca, N. Y.
Berry, J. S., Supt. B. and B., S. L. S. W. Ry., St. Louis, Mo.
Bibb, J. M., Supvr. B. and B., L. & N. R. R., Birmingham, Ala.
Bigelow, F. M., Supv. B. & B., L. A. & S. L. R. R., Salt Lake City.
Bishop, McClellan, Mast. Carp., C. R. I. & P. Ry., El Reno, Okla

Bishop, R. R., For. B. and B., L. A. & S. L. R. R., Salt Lake City.
Black, G. W., Div. For. B. & B., Ill. Trac. Sys., Mackinaw, Ill.
Black, J. D., Supvr. B. and B., P. M. R. R., Saginaw, Mich.
Blackwell, J. H., Roadmaster, Sou. Ry., Columbia, S. C.
Blake, L. M., Supv. B. & B., B. & M. R. R., St. Johnsbury, Vt.
Blowers, S. H., For. Carp., B. & O. R. R., Columbus, O.
Bock, J. G., Gen. Br. Insp., C. St. P. M. & O. Ry., St. Paul, Minn.
Bohland, J. A., Br. Engr., G. N. Ry., St. Paul, Minn.
Bonner, J. K., Asst. Supvr. B. & B., N. Y. C. R. R., Rochester, N. Y.
Bourgeois, F. J., Supv. B. & B., N. O. G. N. R. R., Bogalusa, La.
Bouton, W. S., Engr. of Bridges, B. & O. R. R., Baltimore Md.
Bowers, Stanton, Mast. Carp., P. C. C. & St. L. Ry., Bradford, O.
Bowers, S. C., Mast. Carp. of Brdgs., P. C. C. & St. L. Ry., Steubenville, O.
Bowman, R. M., Asst. Engr., L. E. & W. R. R., Indianapolis, Ind.
Boyd, G. E., Div. Engr., D. L. & W. R. R., Buffalo, N. Y.
Boyer, Grant, Div. For. B. & B., M. C. R. R., Detroit, Mich.
Brantner, Z. T., Supt. M. of W. Shops, B. & O. R. R., Martinsburg, W. Va.
Bratten, T. W., Supvr., B. and B., S. P. Co., Oakland Pier, Cal.
Brewer, W. A., Asst. Engr., I. C. C., 914 Karpen Bldg., Chicago.
Bricker, H. R., Inspr. M. of W., B. & O. R. R., Baltimore, Md.
Bridges, T. H., Asst. For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Briggs, B. A., 311 E. Cache la Paudre St., Colorado Springs, Colo.
Brookhart, N. D., Asst. Supv. B. & B., O. S. L. R. R., Pocatello, Idaho.
Brown, Alf., B. & B. Inspr., P. E. Ry., Los Angeles, Cal.
Brown, C. W., Sou. Pac. Co., Mina, Nevada.
Brown, Thos., Br. Inspr., P. M. R. R., Saginaw, Mich.
Browne, J. B., Gen'l For. B. and B., K. C. C. & S. Ry., Clinton, Mo.
Browne, J. S., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
Bruce, R. J., Genl. Bldg. Inspr., Mo. Pac. Ry., St. Louis, Mo.
Buck, A. J., Chief Carpenter, C. M. & St. P. Ry., Tacoma, Wash.
Buckley, J. E., Supvr. B. & B., B. & M. R. R., Nashua, N. H.
Bulger, Hugh, For. B. & B., Sou. Pac. Co., Oakland Pier, Cal.
Burgess, W. H., Supvr. B. & B., Sou. Pac. Co., Stockton, Cal.
Burke, Daniel, Supvr. B. and B., Sou. Pac. Co., Tucson, Ariz.
Burckhalter, F. L., Supt. Sou. Pac. Co., Portland, Ore.
Burnett, W. L., For. B. & B., St. L. I. M. & S. Ry., Eudora, Ark.
Burns, W. E., Asst. Engr., Sou. Pac. Co., Portland, Ore.
Burpee, Moses, Chief Engr., B. & A. R. R., Houlton, Maine.
Burrell, F. L., Gen'l For. B. and B., C. & N. W. Ry., Fremont, Neb.
Byrd, J. E., Asst. For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Byrd, L. J., For. B. & B., St. L. I. M. & S. Ry., Dermott, Ark.
Byrd, W. E., Asst. For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.

Cahill, E., Genl. For. B. & B., D. L. & W. R. R., Scranton, Pa.
Caldwell, J. M., Insp. B. and B., C. I. & L. Ry., Lafayette, Ind.
Caldwell, J. T., For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Camp, W. M., Editor, Railway Review, Chicago, Ill.
Candee, Eldridge E., Sup B & B, N Y N H &HRR, New London, Conn.
Candee, Elliot E., Dist. Br. For., N Y N H & H R R, Waterbury, Conn.
Canty, J. P., Supvr. B. and B., B. & M. R. R., Fitchburg, Mass.
Cardwell, W. M., Mast. Carp., W. T. Co., Washington, D. C.
Carmichael, Wm., St. J. & G. I. R. R., St. Joseph, Mo.
Carpenter, J. T., 1101 Upper 3rd St., Evansville, Ind.
Case, F. M., For. W. S., C. & N. W. Ry., Belle Plaine, Ia.
Casey, W. W., For. B. & B., K. C. S. Ry., Texarkana, Texas.
Catchot, A. J., Supvr. B. & B., L. & N. R. R., Ocean Springs, Miss.
Cayley, W., Supvr., G. T. Ry., Stratford, Ont.
Christy, B. B., Br. For., S. A. L. Ry., Tallahassee, Fla.
Clark, H. W., Supv. B. & B., Mo. Pac. Ry., Falls City, Neb.
Clark, J. H., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
Clark, W. A., Chief Engr., D. & I. R. R. R., Duluth, Minn.

Clopton, A. S., Supvr. B. & B., M. K. & T. Ry., Oklahoma City, Okla.
Clothier, E. E., Chief Carp., C. M. & St. P. Ry., Mobridge, So. Dak.
Cole, J. E., Gen'l Inspr., Sou. N. E. Ry., Providence, R. I.
Conn, F. J., Supvr. B. & B., C. N. O. & T. P. Ry., Lexington, Ky.
Connolly, C. G., Gen. For. Eng. Dept., D. L. & W., Buffalo, N. Y.
Connor, R. E., Supvr. B. & B., Southern Ry., Columbia, S. C.
Cooper, H. A., Roadmaster, T. I. Ry., Gananoque, Ont.
Copland, A. C., Office Engr., C. & O. Ry., Richmond, Va.
Copp, J. P., Mast. Carp., C. R. I. & P. Ry., Haileyville, Okla.
Corbin, W. S., For. B. and B., Sou. Pac. Co., San Pedro, Cal.
Corey, S. T., Ch. Dftsman, Br. Dept., C. R. I. & P. Ry., Chicago.
Cota, G. M., Ch. Clerk, Eng. Dept., C. Vt. Ry., St. Albans, Vt.
Counts, D. E., Supv. B. & B., W. & A. R. R., Dalton, Ga.
Cowsert, L. A., Supv. W. S., C. N. O. & T. P. Ry., Danville, Ky.
Crawford, J. A., B. & B. Master, C. N. Ry., Saskatoon, Sask.
Crites, G. S., Asst. Engr., B. & O. S. W. R. R., Cincinnati, O.
Crosman, D. M., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
Cullen, F. P., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Cullen, J. F., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Cummin, Joseph H., Bay Shore, N. Y.
Cunningham, A. O., Chief Engr., Wabash R. R., St. Louis, Mo.
Curtin, William, Contractor, Govan, Saskatchewan.

Dale, Chas., For. W. S., I. C. R. R., New Orleans, La.
Dalstrom, O. F., Ch. Dftsman, Br. Dept., C. & N. W. Ry., Chicago.
Danes, E. C., Gen. For., Wabash R. R., Peru, Ind.
Danes, W. S., Engr. M. of W., Wabash R. R., Peru, Ind.
Dawley, W. S., 5657 Cabanne Ave., St. Louis, Mo.
Decker, H. H., Contractor, 2915 Ingersoll Ave., Des Moines, Ia.
Degnan, L. V., 1834 Hearst Ave., Berkeley, Cal.
Demars, E. A., For. W. S., O. S. L. R. R., Salt Lake City.
Derr, W. L., Supt., C. G. W. R. R., Clarion, Iowa.
Dickson, Geo., For. Brdgs., Sou. Pac. Co., Oakland, Cal.
Dittmar, F. C., Br. For., Sou. Pac. Co., Los Angeles, Cal.
Donaldson, C. E., Actg. G. F. B. & B., C. Vt. R. R., St. Albans, Vt.
Drake, R. M., M. of W. Asst., Sou. Pac. Co., San Francisco, Cal.
Draper, F. O., Supt. of Bridges, I. C. R. R., Chicago.
Draper, I. A., Steel Erec. For., O. S. L. R. R., Pocatello, Idaho.
Drum, H. R., Chief Carp., C. M. & St. P. Ry., Mitchell, S. D.
Duckett, W. E., Asst. Engr., C. M. & St. P. Ry., Minneapolis, Minn.
Dufort, S. E., Gen. For. B. & B., B. & M. R. R., Lowell, Mass.
Dupree, James, For. W. S., C. T. H. & S. E. Ry., Crete, Ill.
Durfee, T. H., For. B. and B., C. & N. W. Ry., Huron, S. D.

Eastman, J. S., Idaho Falls, Idaho.
Easton, G. A., Scale Insp., Sou. Pac. Co., West Oakland, Cal.
Edwards, W. R., Sr. Struct. Engr., I. C. C., Washington, D. C.
Eggers, C. H., Mast. Carp., C. R. I. & P. Ry., Little Rock, Ark.
Eggleston, H. H., Supvr. B. & B., C. G. W. R. R., Des Moines, Ia.
Eggleston, W. O., Insp. of Bridges, Erie R. R., Huntington, Ind.
Elder, W. E., Mast. Carp., C. B. & Q. R. R., Burlington, Iowa.
Elliott, R. O., Supvr. B. and B., L. & N. R. R., Nashville, Tenn.
Elwell, H. A., Supvr. B. & B., C. G. W. Ry., Clarion, Ia.
Esping, Chas., Mast. Carp., B. & O. C. T. R. R., Chicago.
Ettinger, C., Gen. Ptr. For., I. C. R. R., Chicago.
Evans, J. J., Supvr. Signals, P. M. R. R., Saginaw, Mich.
Fair, E. W., Supvr. B. & B., B. R. & P. Ry., Du Bois, Pa.
Fake, C. H., Engr. M. of W., M. R. & B. T. Ry., Bonne Terre, Mo
Farlow, R. F., Mast. Carp., B. & O. S. W. R. R., Chillicothe, O.
Faulkner, L. E., Ch. Engr., Miss. Cent. R. R., Hattiesburg, Miss.

Fellows, C. W., For. W. S., C. & S. Ry., Denver, Colo.
Fenwick, G. H., Gen. Br. For., M. C. R. R., St. Thomas, Ont.
Ferdina, A. H., For. B. & B., St. L. I. M. & S. Ry., St. Louis.
Ferris, B. F., For. B. and B., Sou. Pac. Co., Los Angeles.
Findley, A., 929 Wash. Ave., Portland, Me.
Finley, W. H., Ch. Engr., C. & N. W. Ry., Chicago.
Fisher, J. F., Bridge Inspr., Sou. Pac. Co., Sacramento, Cal.
Fisher, Morris, Supvr. B. & B., Sou. Pac. Co., Ogden, Utah.
Fisk, C. H., Ch. Engr. Const., St. Louis, 5142 Westminster Pl., St. Louis.
Fitzgerald, J. M., Supvr. B. & B., C. of G. Ry., Macon, Ga.
Fletcher, J. W., Roadway Supt., Car. & N. W. Ry., Chester, S. C.
Fletcher, W. H., 108 7th Ave., Nashville, Tenn.
Flint, C. F., For. B. and B., C. V. R. R., St. Albans, Vt.
Floren, E. R., Mast. Carp., C. R. I. & P. Ry., Rock Island, Ill.
Flynn, M. J., For. B. and B., C. & N. W. Ry., Chicago.
Forsgren, Oscar, Brigham, Utah.
Fraser, Alex., Supvr. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Fraser, James, Ch. Engr., N. S. W. Govt. Rys., Sydney, N. S. W.
Fraser, Neil, Gen'l Br. For., Sou. Pac. Co., Mayfield, Cal.
Frazier, W. C., Supvr. B. and B., L. A. & S. L. Ry., Los Angeles.
Fritz, Phil., For. B. & B., Sou. Pac. Co., Los Angeles.
Froese, Julius, Gen. For. B. & B., A. T. & S. F. Ry., LaJunta, Colo.
Fullerton, J. H., Supv. B. & B., B. & M. R. R., Woodsville, N. H.

Gable, Franklin, For. Carp., P. & R. Ry., Catawissa, Pa.
Gaby, F. A., Ch. Engr. P. C. of Ont., Toronto, Ont.
Gagnon, Ed., Supvr. B. and B., M. & St. L. R. R., Minneapolis, Minn.
Galloway, W. J., Mast. Carp., S. A. L. R. R., Hamlet, N. C.
Gardner, E. F., Mast. Carp., Erie R. R., Buffalo, N. Y.
Garner, R. D., Engr. Const., S. N. E. Ry., Providence, R. I.
Gaskin, W., Scale Inspr., Sou. Pac. Co., Los Angeles, Cal.
Gaunt, Fred, Ptr. For., O. S. L. R. R., Pocatello, Idaho.
Gaut, J. B., Supt. B. & B., G. T. Ry., Chicago.
Gauthier, A. I., Supvr. B. & B., B. & M. R. R., Concord, N. H.
Gehr, B. F., Mast. Carp., P. C. C. & St. L. Ry., Richmond, Ind.
Gentis, Ira, B. and B. Foreman, Sou. Pac. Co., Oakland, Cal.
George, W. J., Bay Road, Claremont, W. Australia.
Gilman, A. F., Asst. Engr., C. St. P. M. & O. Ry., St. Paul, Minn.
Giusto, Peter, For. B. & B., Sou. Pac. Co., San Francisco.
Given, J. A., Asst. Div. Engr., Sou. Pac. Co., Sacramento, Cal
Glasgow, J. F., Gen. For. B. & B., C. St. P. M. & O. Ry., Worthington, Minn.
Gnadt, C., Br. For., St. L. I. M. & S. Ry., Poplar Bluff, Mo.
Gokey, J. C., For. Water Service, G. T. Ry., Richmond, Que.
Goldmark, Henry, Cons. Engr., 103 Park Ave., New York City.
Goldsmith, E. L., Supt. Const., L. I. R. R., Jamaica, N. Y.
Gooch, C. W., 1325 W. 9th St., Des Moines, Ia.
Gradt, Chas. Ch. Carp., C. M. & St. P. Ry., Savanna, Ill.
Graham, F. N., Asst. Engr., D. M. & N. Ry., Duluth, Minn.
Graham, Wm., C. E., 3027 Windsor Ave., Baltimore, Md.
Gratto, James, Supvr. B. & B., S. P. Co., Los Angeles, Cal.
Graves, Lon, For. B. & B., St. L. I. M. & S. Ry., Dermott, Ark.
Green, C. F., Supvr. B. and B., Sou. Pac. Co., Sacramento, Cal.
Green, E. H. R., Pres., Texas Midland R. R., Terrell, Tex.
Green, Z. A., Pilot, Fed. Val., G. C. & S. F. Ry., Galveston, Tex.
Greiner, J. E., Civil Engineer, 605 Continental Bldg., Baltimore, Md.
Griffith, F. M., Supvr. B. and B., C. & O. Ry., Covington, Ky.
Grover, J. H., Gen. For. W. S., A. T. & S. F. Ry., Fresno, Cal.
Grover, O. L., Asst. Engr., C. & O. Ry., Richmond, Va.
Guild, Edward, Supv. B. & B., P. M. R. R., Grand Ledge, Mich.
Guire, W. A., For. B. & B., St. L. I. M. & S. Ry., Lake Providence, La

Guppy, B. W., Engr. Structures, B. & M. R. R., Boston, Mass.
Guretzky, J., Supvr. B. &. B., Col. Mid. Ry., Colorado City, Colo.

Hadwen, L. D., Engr. Masy. Const., C. M. & St. P. Ry., Chicago, Ill.
Haley, W. S., Res. Engr., N. Y. C. R. R., Toledo, O.
Hall, N. L., Supvr. B. & B., Sou. Ry., Greensboro, N. C.
Hall, Thomas, Asst. Supt. Bldgs., M. C. R. R., Jackson, Mich.
Hampton, H. A., Asst. Div. Engr., Sou. Pac. Co., Portland, Oregon.
Hancock, John, Engr. B. &. B., U. Trac. Co. of Ind., Anderson, Ind.
Hand, Geo. W., Valuation Engr., C. & N. W. Ry., Chicago.
Hanks, G. E., 814 No. Wash. Ave., Saginaw, Mich.
Hansen, Robt., Carp. For., Sou. Pac. Co., West Oakland, Cal.
Hansen, Rupert, 517 Redondo Ave., Salt Lake City, Utah.
Hargrove, J. C., For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Harlow, A. W., Mast. Carp., Erie R. R., Huntington, Ind.
Harman, H. H., Engr. of Brs., B. & L. E. R. R., Greenville, Pa.
Harman, Wm. C., Br. Inspr., Sou. Pac. Co., Bakersfield, Cal.
Harris, C. J., For. B. and B., O. S. L. R. R., Roberts, Idaho.
Harris, W. B., Asst. R. of W. Agt., M. & O. R. R., Mobile, Ala.
Harrison, Chas., Gen. For. B. & B., M. O. & G. Ry., Muskogee, Okla.
Harshbarger, C. A., Asst. Br. For., O. S. L. Ry., Ontario, Ore.
Hartley, James, Supvr. B. and B., N. P. Ry., Staples, Minn.
Harvey, E. H., St. L. I. M. & S. Ry., Montrose, Ark.
Hausgen, W., Supvr. B. and B., M. P. Ry., Sedalia, Mo.
Hawk, A. T., Archt., C. R. I. & P. Ry., Chicago.
Hawkins, E. P., Genl. R. M., St. L. I. M. & S. Ry., McGehee, Ark.
Henderson, J., Foreman B. and B., G. T. Ry., St. Thomas, Ont.
Henderson, R. C., Mast. Carp., C. H. & D. Ry., Dayton, O.
Herrig, C., For. W. S., C. & N. W. Ry., Wall Lake, Iowa.
Hicks, Wm. G., M. of W. Dept., L. I. R. R., Jamaica, N. Y.
Higgins, H. K., Cons. Engr., 209 McBride St., Jackson, Mich.
Hill, H. R., Asst. Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
Hinchee, J. M., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
Hitesman, U. S., Gen. For., N. Y. C. R. R., New York City.
Hodges, F. J., C. C., M. C. R. R., Jackson, Mich.
Hodges, H. P., Asst. Engr. W. S., N. C. & St. L. Ry., Nashville, Tenn.
Hoffman, Geo. M., For. Ptr., P. & R. Ry., Shamokin, Pa.
Hofecker, Peter, Supvr. B. and B., L. V. R. R., Auburn, N. Y.
Holcomb, J. W., Supvr. B. & B., L. V. R. R., Buffalo, N. Y.
Holdridge, H. D., Supvr. B. and B., Y. & M. V. R. R., Vicksburg, Miss.
Hopke, W. T., Mast. Carp., B. & O. R. R., Grafton, W. Va.
Horning, H. A., Supt. of Bldgs., M. C. R. R., Jackson, Mich.
Horth, A. J., Mast. Carp., Erie R. R., Meadville, Pa.
Hotson, Wm. B., Supt. B. & B., E. J. & E. Ry., Joliet, Ill.
Howson, E. T., Eng. Editor, Railway Age Gazette, Chicago, Ill.
Hubbard, A. B., 32 Banks St., West Somerville, Mass.
Hudson, B. M., Supt. T. & B. V. Ry., Teague, Tex.
Hull, K. S., Supt., G. C. & S. F. Ry., Temple, Tex.
Humbert, A. T., Mast. Carp., B. & O. R. R., New Castle Jct., Pa.
Hume, E. S., Deputy Com'r., W. A. Govt. Rys., Perth, W. Australia.
Hunciker, John, For. Bridge Erection, C. & N. W. Ry., Chicago.
Huntoon, J. S., Ch. Br. Insp., M. C. R. R., Detroit, Mich.
Hurst, Walter, Inspector, C. B. & Q. Ry., Chicago, Ill.
Hutchens, J. A., Bridge Insp., Sou. Pac. Co., Ogden, Utah.

Ingalls, F., Supvr. B. and B., N. P. Ry., Jamestown, N. D.
Ingram, Floyd, Supvr. B. and B., L. & N. R. R., Erin, Tenn.
Innes, J., Gen. For., G. T. Ry., Hamilton, Ont.
Irving, T. J., Asst. Engr., C. & N. W. Ry., Boone, Iowa.
Irwin, J. W., Genl. For. B. & B., C. & N. W. Ry., Chadron, Neb.
Isaacs, Jno. D., Consulting Engr., Sou. Pac. Co., New York City.

Jack, H. M., Gen'l For. B. and B., I. & G. N. R. R., Palestine, Tex.
Jackson, E. A., For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Jackson, W. J., Div. Engr., C. & N. W. Ry., Winona, Minn.
James, A. J., Gen. For. B. & B., A. T. & S. F. Ry., Topeka, Kans.
James, Harry, Gen'l For. B. and B., C. & S. Ry., Denver, Col.
James, R. E., Supv. B. & B., L. V. R. R., Hazelton, Pa.
Jardine, Hugh, Asst. Engr., Intercolonial Ry., Moncton, N. B.
Jennings, Geo. H., Asst. Ch. Engr., E. J. & E. Ry., Joliet, Ill.
Jensen, C. A., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
Jewell, J. O., Supt. B. and B., C. T. H. & S. E. Ry., Terre Haute, Ind
Johnson, C. H., For. B. & B., P. M. R. R., Reese, Mich.
Johnson, Maro, Asst. Engr., I. C. R. R., Chicago.
Johnson, Phelps, Pres. St. Lawrence Bridge Co., Montreal, Que.
Johnston, C. E., Genl. Mgr., K. C. Sou. Ry., Kansas City, Mo.
Johnston, J. H., Supt. B. & B., G. T. Ry., Montreal, Que.
Jonah, F. G., Chief Engr., St. L. & S. F. R. R., St. Louis, Mo.
Jonas, H. F., Engr. Struct., S. P. Lines, Tex. & La., Houston, Tex
Jones, L. E., Asst. Engr., N. O. & N. E. R. R., New Orleans, La.
Joslin, Judson, Genl. For. B. & B., L. V. R. R., Auburn, N. Y.
Jutton, Lee, Div. Engr., C. & N. W. Ry., Madison, Wis.

Keefe, D. A., Consulting Engr., Athens, Pa.
Keith, H. C., Civil Engineer, 154 Nassau St., New York City.
Kelly, C. W., Peoples Gas Building, Chicago.
Kelly, J. A., Gen. For. Brs., O. S. L. R. R., Pocatello, Idaho.
Kemp, A. E., For. B. & B., L. V. R. R., Hazleton, Pa.
Kibbey, G. S., Asst. Engr., M. & St. L. R. R., Minneapolis, Minn.
Killam, A. E., 84 Highfield St., Moncton, N. B.
Killian, J. A., Res. Engr., Sou. Ry., Charlotte, N. C.
King, A. H., Supvr. B. and B., O. S. L. R. R., Pocatello, Idaho.
King, C. F., Div. Engr., C. & N. W. Ry., Omaha, Neb.
King, F. E., Dist. Carp., C. M. & St. P. Ry., Minneapolis, Minn.
King, T. H., Supv. B. & B., L. & N. R. R., Knoxville, Tenn.
Kinney, G. W., Inspr. B. & B., D. & R. G. R. R., Salt Lake City.
Kinzie, H. H., Supvr. B. and B., N. Y. N. H. & H. R. R., Taunton, Mass
Klumpp, G. J., Supvr. Bridges, N. Y. C. R. R., Rochester, N. Y.
Knapp, F. A., Mast. Carp., Erie R. R., Jersey City, N. J.
Knapp, G. A., Office Engr., G. C. & S. F. Ry., Galveston, Tex.
Knowles, C. R., Supt. Water Service, I. C. R. R., Chicago.
Krausch, W. T., Engr. Bldgs., C. B. & Q. R. R., Chicago, Ill.
Kulp, B. R., Div. Engr., C. & N. W. Ry., Antigo, Wis.
Kurokochi, S., Engineer, Imperial Govt. Rys., Tokyo, Japan.

Lacy, J. D., Insp., S. A. & A. P. Ry., 2517 Saltus St., Houston, Tex.
Lacy, W. J., For. B. & B., St. L. I. M. & S. Ry., Poplar Bluff, Mo.
La Fountain, N. H., Asst. Supt. of B. and B., C. M. & St. P. Ry., Chicago
Lamb, C. W., For. B. & B., St. L. I. M. & S. Ry., Pine Bluff, Ark.
Land, G. W., Supvr. B. and B., St. L. I. M. & S. Ry., McGehee, Ark.
Lane, E. G., Dist. Engr. M. of W., B. & O. R. R., Cincinnati, O.
Lanning, W. R., Ch. Carp., C. M. & St. P. Ry., St. Maries, Idaho.
Large, H. M., Mast. Carp., G. R. & I. Ry., Fort Wayne, Ind.
Larsen, A., Res. Engr., S. N. E. R. R., Millville, Mass.
Larson, John, Room 740, Transportation Bldg., Chicago.
Lattin, W. V., Supv. B. & B., N. Y. N. H. & H. R. R., Hartford, Conn.
Lawrence, P. P., Asst. Supvr. B. & B., L. E. & W. R. R., Tipton, Ind.
Layfield, E. N., Secy. W. S. C. E., 1735 Monadnock Block, Chicago.
Leach, W. A., Foreman, S. N. E. R. R., Providence, R. I.
Leake, T. S., Contractor, 6433 Kenwood Ave., Chicago.
Leavitt, F. J., Div. For. B. and B., B. & M. R. R., Sanbornville, N. H.
Lee, Frank, Prin. Asst. Engr., C. P. R., Winnipeg, Manitoba.
Lemond, J. S., Engr., M. of W., Southern Ry., Charlotte, N. C.

Lentz, C. W., Genl. Bridge Insp., I. C. R. R., Chicago, Ill.
Leonard, H. R., Engr. B. and B., P. R. R., Philadelphia, Pa.
Leslie, Andrew, Div. For., M. C. R. R., St. Thomas, Ont.
Lewis, E. R., Asst. to G. M., D. S. S. & A. Ry., Duluth, Minn.
Lichty, C. A., Gen'l Insp., C. & N. W. Ry., Chicago.
Little, J. W., Asst. Supvr., B. & B., L. & N. R. R., Birmingham, Ala.
Littlefield, E. C., Ch. Clk., N. Y. N. H. & H. R. R., New Haven, Conn.
Lloyd, F. F., C. E., 1365 Taylor St., San Francisco, Cal.
Lodge, Harry, For. B. & B., Sou. Pac. Co., (care of G. W. Rear).
Loeffler, M., Supv. Brs., L. I. R. R., Jamaica, N. Y.
Loftin, E. L., Supvr. B. and B., Q. & C. Ry., Vicksburg, Miss.
Long, M. A., Asst. to Ch. Engr., B. & O. R. R., Baltimore, Md.
Lorch, J. A., Asst. Engr., C. & N. W. Ry., Chicago.
Loughery, E., Gen'l For. B. & B., T. & P. Ry., Dallas, Tex.
Loughnane, George, Div. Engr., C. & N. W. Ry., Escanaba, Mich.
Loweth, C. F., Ch. Engr., C. M. & St. P. Ry., Chicago.
Lutken, P. K., Gen. For. B. & B., N. O. M. & C. R. R., Laurel, Miss.
Lydston, W. A., 105 Norfolk Ave., Swampscott, Mass.
Lyman, C. R., For. Brgs., C. Vt. Ry., Waterbury, Vt.

Mace, B. S., Supt. of Insurance, B. & O. R. R., Baltimore, Md.
Mackenzie, W. B., Civil Engineer, Moncton, N. B.
Macy, E. C., Supt. Const., Stone & Webster Eng. Corpn., 868 Stuart Bldg., Seattle, Wash.
Mahan, Wm., Mast. Carp., W. & L. E. R. R., Canton, Ohio.
Malloy, J. B., For. B. & B., Sou. Pac. Co., San Francisco.
Mann, J. M., Gen'l For. B. and B., Ft. W. & D. C. Ry., Ft. Worth, Tex.
Manley, B. F., Foreman B. & B., Pac. Elec. Ry., Los Angeles, Cal.
Manthey, G. A., Asst. Supt. B. & B., Soo Line, Minneapolis, Minn.
Marcy, C. A., For. B. and B., C. & N. W. Ry., Chicago.
Markley, A. S., Mast. Carp., C. & E. I. R. R., Danville, Ill.
Markley, J. H., Mast. B. and B., T. P. & W. Ry., Peoria, Ill.
Marsh, John, For. B. and B., B. & M. R. R., Lawrence, Mass.
Marsh, M. M., Supt. W. & B., Northern Ry., Squirres, Costa Rica, C. A.
Maruyama, Y., C. E., Sou. Manchuria Ry., Dairen, Japan.
Massenburg, W. G., Engr. Gulf Lines, G. C. & S. F. Ry., Galveston, Tex.
Mathews, J. D., Div. Engr., Sou. Pac. Co., Tucson, Ariz.
Matthews, W. H., Mast. Carp., Erie R. R., Hornell, N. Y.
Mattos, F. D., Supt. Pres. Wks., S. P. Co., W. Oakland, Cal.
May, A. D., Asst. Engr., Mo. Pac. Ry., Little Rock, Ark.
Mayer, M. J., Ch. Draftsman, Sou. Pac. Co., San Francisco, Cal.
McCabe, E. M., Supv. B. & B., B. & A. R. R., Pittsfield, Mass.
McCandless, C. W., For. B. & B., Sou. Pac. Co., Ventura, Cal.
McCann, E., Gen. For. B. and B., A. T. & S. F. Ry., Wellington, Kans.
McCaulley, S. W., C. E., 6106 Kenwood Ave., Chicago, Ill.
McCloy, A. L., For. B. & B., P. M. R. R., Reese, Mich.
McClure, J. C. E., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
McCormick, R. S., Ch. Engr., A. C. & H. B. R., Sault Ste. Marie, Ont.
McCoy, W. H., Asst. Engr., Sou. Pac. Co., Dunsmuir, Cal.
McCue, G. C., Gen. Supvr. B. & B., G. T. Ry., Ottawa, Ont.
McCully, C. S., Gen'l For. B. and B., N. P. Ry., Jamestown, N. D.
McDearmid, W. A., Mast. Carp., S. A. L. Ry., Charleston, S. C.
McDonald, Hunter, Ch. Engr., N. C. & St. L. Ry., Nashville, Tenn.
McFadden, T. E., Chief Carp., C. M. & St. P. Ry., Cedar Falls, Wash.
McGee, Danl., For. B. & B., Sou. Pac. Co., Sacramento, Cal.
McGonagle, W. A., Pres., D. M. & N. Ry., Duluth, Minn.
McIlhenny, O. R., Asst. Supv., N. O. & N. E. R. R., Laurel, Miss.
McIntosh, Wm., Castle Stuart, Dalcross, Inverness-shire, Scotland.
McIver, B. T., Supvr. B. and B., D. & I. R. R. R., Two Harbors, Minn.
McKay, A. G., Div. For. Bldgs., N Y N H & H R R., New Haven, Conn.

McKee, D. L., Mast. Carp., P. & L. E. R. R., McKee's Rocks, Pa.
McKee, H. C., Insp. of Iron Bridges, C. of G. R. R., Macon, Ga.
McKee, R. J., Supvr. B. and B., I. C. R. R., Freeport, Ill.
McKeel, W. S., Mast. Carp., G. R. & I. Ry., Grand Rapids, Mich.
McKibben, Robert, Mast. Carp., P. R. R., Altoona, Pa.
McLean, Neil, Bridge Inspector, Erie R. R., Huntington, Ind.
McLeod, Angus M., For. B. & B., Sou. Pac. Co., Oakland, Cal.
McNab, A., Supvr. B. and B., P. M. R. R., Holland, Mich.
McNaughton, H. C., Div. For. B. & B., B. & M. R. R., Concord, N. H.
McQueen, A., Gen. For. Brs., D. L. & W. R. R., Scranton, Pa.
McRae, D. A., Carp. For., C. P. R., Lethbridge, Alberta.
McRostie, Roy, Asst. For. Const., O. S. L. R. R., Pocatello, Ida.
McVay, A. B., Supvr. B. and B., L. & N. R. R., Evansville, Ind.
Mellgren, J., For. W. S., C. & N. W. Ry., Eagle Grove, Iowa.
Meloy, E. S., Asst. Engr., C. M. & St. P. Ry., Chicago.
Mercier, A. T., Div. Engr., Sou. Pac. Co., Los Angeles, Cal.
Meyer, H. W., 111 N. 8th St., Allentown, Pa.
Meyers, W. F., For. B. and B., C. & N. W. Ry., Boone, Iowa.
Middleton, R. J., Val. Engr., C. M. & St. P. Ry., Chicago, Ill.
Miller, A. F., Mast. Carp., Penn. Lines W. of Pitts., Chicago.
Miller, C. E., Asst. Gen. Br. Insp., C. & N. W. Ry., Chicago.
Miller, J. W., Archt., C. & N. W. Ry., Chicago.
Miller, M. D., Spl. Engr., 740 Transportation Bldg., Chicago.
Mills, R. P., Supvr. Bldgs., N. Y. C. R. R., New York City.
Mines, Chas., Gen. For. B. & B., C. St. P. M. & O. Ry., Emerson, Neb.
Mitchell, G. A., Supt. B. and B., G. T. Ry., Toronto, Ont.
Moen, J. D., Supt. B. & B., C. St. P. M. & O. Ry., St. Paul, Minn.
Montzheimer, A., Ch. Engr., E. J. & E. Ry., Joliet, Ill.
Moore, E. G., For. Carpenter, B. & O. R. R., Flatwoods, W. Va.
Moore, W. H., Eng. of Brgs., N. Y. N. H. & H. R. R., New Haven, Conn
Morgan, Homer, For. B. & B., P. M. R. R., Greenville, Mich.
Morrison, E. C., Div. Engr., Sou. Pac. Co., San Francisco.
Mountain, G. A., Ch. Engr., Ry. Com. of Canada, Ottawa, Ont.
Mountfort, Albert, Div. For. B. and B., B. & M. R. R., Nashua, N. H.
Mulcahy, W. H., For. B. & B., C. & N. W. Ry., Adams, Wis.
Munson, S. P., Chief Clerk, I. C. R. R., Mattoon, Ill.
Murphy, J. J., For. Water Service, Sou. Pac. Co., Oakland, Cal.
Murphy, R. E., For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Murray, J. R., Supvr. B. & B., A. G. S. R. R., Tuscaloosa, Ala.
Murray, Edwd., Asst. Engr. B. & B., C. M. & St. P. Ry., Miles City, Mont
Musgrave, C. T., For. B. & B., O. S. L. R. R., Idaho Falls, Idaho.
Musser, D. G., Mast. Carp., Penn. Lines W. of Pitts., Wellsville, Ohio

Nelson, J. C., Engr. M. of W., S. A. L. Ry., Norfolk, Va.
Nelson, O. T., Supt. M. of W., A. & W. P. R. R., Atlanta, Ga.
Nelson, P. N., Gen'l For. of Carp., S. P. Co., San Francisco, Cal.
Nelson, M. E., Engr. Brdgs., A. C. L. R. R., Wilmington, N. C.
Newton, E. O., Div. For. Bldgs., N. Y. N. H. & H. R. R., Danbury, Conn.
Newton, R., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Nies, A. B., Archt., M. C. R. R., Jackson, Mich.
Noland, W. B., Supvr. B. & B., O. A. & E. Ry., Sacramento, Cal.
Noon, W. M., 617 Ave. G., Miami, Fla.
Nuelle, J. H., Genl. Supt., N. Y. O. & W. R. R., Middletown, N. Y.
Nuss, G. K., G. F. B. & B., D. M. & N. Ry., Proctor, Minn.

O'Connor, W. F., Supvr. Bridges, L. I. R. R., Flushing, N. Y.
Oliver, W. H., Div. Engr., A. T. & S. F. Ry., San Bernardino, Cal.
O'Neill, P. J., Mast. Carp., N. Y. C. R. R., Adrian, Mich.
Osborn, F. C., Consulting Engineer, 740 Engineer's Bldg., Cleveland, O.

Owen, John, For. B. & B., D. & M. Ry., East Tawas, Mich.
Page, A. A., Div. For. B. & B., B. & M. R. R., Wilmington, Mass.
Palmer, E. F., For. B. & B., B. & M. R. R., Salem, Mass.
Parker, J. F., Gen. For. B. & B., A. T. & S. F. Ry., San Bernardino, Cal.
Parker, W. V., B. & B. Dept. St. L. S. W. Ry., Malden, Mo.
Parks, J., 3347 Boulevard F., Denver, Colo.
Parsons, P. E., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Paterson, E. E., Plumber For., O. S. L. R. R., Pocatello, Idaho.
Patterson, S. F., Secretary Emeritus, Concord, N. H.
Pauba, A. W., For. B. and B., C. & S. Ry., Denver, Colo.
Peabody, K., Asst. Supv. Bldgs., N. Y. C. R. R., New York City.
Penwell, J. N., Supvr. B. and B., L. E. & W. Ry., Tipton, Ind.
Perkins, H. D., 1501 Walnut St., Danville, Ill.
Pettis, W. A., Gen. Supv. Bldgs., N. Y. C. R. R., Rochester, N. Y.
Phillips, B. P., Asst. Sup. B & B, N Y N H & H R R, Willimantic, Conn.
Pickering, B. F., Supvr. B. & B., B. & M. R. R., Salem, Mass.
Pickering, F. M., Trainman B. & M. R. R., Salem, Mass.
Pierce, Roy, Mast. Carp., Erie R. R., Salamanca, N. Y.
Pinson, J. F., Asst. Engr. B. & B., C. M. & St. P. Ry., Seattle, Wash.
Piper, E. B., Div. For. B. & B., B. & M. R. R., Fitchburg, Mass.
Pitcher, C. G., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Plank, D. E. Supvr. B. and B., Pac. Elec. Ry., Los Angeles, Cal.
Pollard, Harry, Asst. Gen'l Br. Insp., S. P. Co., San Francisco, Cal.
Pollard, Homer, Bridge Inspr., Sou. Pac. Co., West Oakland, Cal.
Pollock, H. H., Mast. Carp. of Bldgs., P. C. C. & St. L. Ry., Carnegie, Pa
Porter, L. H., Box 35, Andover, Conn.
Potter, A. K., Inspector, C. & N. W. Ry., Antigo, Wis.
Potts, J. O., M. of W. Inspr., B. & O. R. R., Baltimore, Md.
Powell, C. E., Genl. Insp. Brgs., C. & O. Ry., Hinton, W. Va.
Powell, S. J., Div. For. B. & B., O. S. L. R. R., Ogden, Utah.
Powers, G. F., Contractor (Newkirk & Powers), Joliet, Ill.

Quinn, William, Supt. B. & B., St. L. S. W. Ry., of T., Tyler, Tex.

Rankin, W. F., Mast. Carp., Pa. Lines West, Cambridge, Ohio.
Ranney, J. E., 3184 Main St., Buffalo, N. Y.
Rask, A. G., Supvr. B. & B., C. St. P. M. & O. Ry., Altoona, Wis.
Ratliff, W. L., Supvr. B. & B., I. C. R. R., McComb, Miss.
Rear, G. W., Gen'l Insp., S. P. Co., San Francisco, Cal.
Redfield, J. A. S., Div. Engr., C. & N. W. Ry., Fond du Lac, Wis.
Redinger, C. A., Res. Engr., Sou. Ry., Old Fort, N. C.
Redmond, C. E., Supvr. B. & B., St. L. I. M. & S. Ry., Van Buren, Ark
Reid, R. H., Supvr. Bridges, N. Y. C. R. R., Cleveland, Ohio.
Replogle, J. S., For. B. & B., Sou. Pac. Co., Oakland, Cal.
Rettinghouse, H., Ch. Engr., C. St. P. M. & O. Ry., St. Paul, Minn.
Reynolds, A. L., Inspr., L. V. R. R., New York City.
Reynolds, A. W., Mast. Carp., P. R. R., Jersey City, N. J.
Reynolds, J. V., For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Rice, A. P., Roadmaster, C. N. & L. R. R., Columbia, S. C.
Rich, B. D., Painter For., Sou. Pac. Co., Stockton, Cal.
Richards, G. T., Supt. B. & B. Shops, C. M. & St. P. Ry., Tomah, Wis.
Richardson, R. W., Div. Engr., C. & N. W. Ry., Sioux City, Ia.
Ridgway, Arthur, Asst. Ch. Engr., D. & R. G. R. R., Denver, Colo.
Riney, M., Gen'l For. B. and B., C. & N. W. Ry., Baraboo, Wis.
Rintoul, D. T., Gen'l For. B. and B., Sou. Pac. Co., Bakersfield, Cal.
Robertson, A. A., Supr. B. and B., N. W. Pac. Ry., San Rafael, Cal.
Robinson, A. L., Br. Inspr., Sou. Pac. Co., Stockton, Cal.
Robinson, A. W., Asst. Engr., O. S. L. R. R., Salt Lake City.
Robinson, J. S., Div. Engr., C. & N. W. Ry., Chicago.
Robinson, John, Supvr. B. and B., P. M. R. R., Grand Rapids, Mich.

Robinson, R. B., Engr. M. of W., O. S. L. R. R., Pocatello, Idaho.
Rodman, G. A., Supt. B. & B., N. Y. N. H. & H. R. R., New Haven, Conn.
Rogers, W. A., Civil Engineer, 37 W. Van Buren St., Chicago.
Rohbock, W. L., Ch. Engr., W. & L. E. R. R., Cleveland. Ohio.
Rohr, E. J., Asst. Br. Supv., C. & O. Ry., Brighton Sta., Cincinnati, O.
Roper, D. L., For. B. & B., St. L. I. M. & S. Ry., Monroe, La.
Rose, Norman, Supvr. B. and B., Sou. Pac. Co., Portland, Ore.
Rose, W. M., For. Water Service, Sou. Pac. Co., Sacramento, Cal.
Ross, William, Chief Carp., C. M. & St. P. Ry., Millbank, S. D.
Rcunseville, D., Eng. Maint., C. & N. W. Ry., Chicago.
Roy, C. M., Gen. Bridge For., L. & N. R. R., Birmingham, Ala.
Ruge, Aug., Supvr. B. & B., C. St. P. M. & O. Ry., Mankato, Minn.
Runyon, C. C., For. B. & B., St. L. I. M. & S. Ry., Gorham, Ill.
Rykenboer, E. J., Supvr. Bldgs., N. Y. C. R. R., Rochester, N. Y.

Salisbury, J. W., Gen. For. D. & W., A. C. L. R. R., Port Tampa, Fla.
Sampson, G. T., Asst. Engr., N. Y. N. H. & H. R. R., Boston.
Sattley, R. C., Valuation Engr., C. R. I. & P. Ry., Chicago.
Scannell, D. W., For. B. & B., L. A. & S. L. R. R., Salt Lake City.
Schall, F. E., Bridge Engr., L. V. R. R., So. Bethlehem, Pa.
Scheetz, F. B., Dept. Valuation, I. C. C., Kansas City, Mo.
Schoolcraft, C. H., For. Brgs., C. Vt. R., Farnham, Que.
Schuessler, W. B., Supvr. B. & B., N Y N H & H R. R., Waterbury, Conn.
Scott, Chas., Supvr. B. & B., B. R. & P. Ry., E. Salamanca, N. Y.
Scribner, C. J., Bldg. Inspr., C. B. & Q. Ry., Chicago.
Searls, Niles, Gen. Fire Inspector, Sou. Pac. Co., San Francisco, Cal.
Secord, Fred, For. B. & B., Sou. Pac. Co., Sacramento, Cal.
Sedmoradsky, C., Asst. For. B. & B., C. St. P. M. & O. Ry., Altoona, Wis.
Sedwell, G. W., Tunnel For., Sou. Pac. Co., Bakersfield, Cal.
Seeley, L. T., For. B. & B., A. T. & S. F. Ry., Needles, Cal.
Seely, S. A., Supvr. B. & B., N. Y. C. R. R., Watertown, N. Y.
Self, E. P., Supv. Bldgs., L. I. R. R., Jamaica, N. Y.
Selig, A. C., Ch. Archt., Intercolonial Ry., Moncton, N. B.
Sellew, W. H., Valuation Dept., M. C. R. R., Detroit, Mich.
Settle, T. H., Gen. For. B. & B., S. P. Co., Los Angeles, Cal.
Shane, A., Box 71, Indianapolis, Ind.
Shanklin, F. E., Gen. For., C. & N. W. Ry., Belle Plaine, Iowa.
Shapleigh, C. H., Asst. Engr., N. O. & N. E. R. R., New Orleans, La.
Sharp, J. S., Res. Engr., N. O. & N. E. R. R., New Orleans, La.
Sharpe, D. W., Supv. B. & B., N. Y. N. H. & H. R. R., New Haven, Conn.
Sharpe, T. E., Supvr. B. and B., Sou. Ry., Greenville, S. C.
Shean, J. R., Ptr. For., Pac. Elec. Ry., Los Angeles, Cal.
Sheldon, J. B., Supvr. B. & B., N. Y. N. H. & H. R. R., Providence, R. I.
Sheley, Wm., Asst. Supvr. B. and B., L. & N. R. R., Evansville, Ind.
Shifflet, Parker, For. Br. Erec., O. S. L. R. R., Pocatello, Idaho.
Shope, D. A., Fresno, Cal.
Shropshire, W., Supvr. of B. and B., Y. & M. V. R. R., Greenville, Miss.
Sibley, C. A., Engr. & Contr., 902 Chapel St., New Haven, Conn.
Siefer, F. M., Ch. Engr., Corvallis & Eastern R. R., Portland, Ore.
Simmons, I. L., Br. Engr., C. R. I. & P. Ry., Chicago.
Sinclair, E. L., Asst. Engr., C. M. & St. P. Ry., Marion, Iowa.
Sisson, F. P., Asst. Engr., G. T. Ry., Detroit, Mich.
Skeoch, Jas., Gen. For. B. & B., D. L. & W. R. R., Dunmore, Pa.
Slabotsky, H., Asst. Engr., M. L. & T. R. R. & S. S. Co., Lafayette, La
Smith, A. W., Bridge Dept. C. N. Ry., Winnipeg, Manitoba.
Smith, C. E., Consulting Engr., 2075 Ry. Exch. Bldg., St. Louis, Mo.
Smith, C. U., Asst. Engr., C. M. & St. P. Ry., Milwaukee, Wis.
Smith, C. W., Asst. Supvr. B. & B., Sou. Pac. Co., Portland, Ore
Smith, E. U., Engr., The Austin Co., Cleveland, O.
Smith, E. W., Architect Val., M. C. R. R., Detroit, Mich.
Smith, G. W., American Bridge Co., Chicago.

Smith, L. D., C. E., Room 18, Ferry Bldg., San Francisco.
Smith, M. A., Gen. For. B. & B., I. C. R. R., New Orleans, La.
Smith, Wm., For. W. S., St. L. I. M. & S. Ry., McGehee, Ark.
Snow, J. P., 1120 Kimball Bldg., Boston, Mass.
Snyder, A. M., Supv. B. & B., L. & N. E. R. R., Pen Argyl, Pa.
Soisson, J. L., Gen'l For. B. and B., N. Y. C. R. R., Norwalk, Ohio.
Sorensen, Wm., For. B. & B., O. S. L. R. R., Brigham, Utah.
Sorrells, O. M., Asst. Div. Engr., N. C. & St. L. Ry., Atlanta, Ga.
Spencer, Jos., For. B. & B., G. T. Ry., Stratford, Ont.
Spencer, Wm., C. & N. W. Ry., Norfolk, Neb.
Stamler, H., Supvr. B. & B., L. & N. R. R., Paris, Ky.
Stannard, James, 1602 Broadway, Kansas City, Mo.
Staten, J. M., Gen'l Bridge Insp., C. & O. Ry., Richmond, Va.
Steadham, J. J., Supv. B. & B., N. O. & N. E. R. R., New Orleans, La.
Steffens, W. F., Special Engr., N. Y. C. Lines, New York City.
Sterling, W. M., Ch. Clerk, C. & N. W. Ry., Chicago.
Stern, I. F., C. E., Old Colony Bldg., Chicago.
Stevens, A. R., For. B. and B., O. S. L. R. R., Pocatello, Idaho.
Stewart, G. H., Master Mason, B. R. & P. Ry., Salamanca, N. Y.
Stewart, John, Gen. For. B. & B., C. St. P. M. & O. Ry., Spooner, Wis.
Stewart, W A., For. Brgs., C. Vt. R. R., New London, Conn.
Stewart, W. G., Supvr. B. and B., L. & N. R. R., Nashville, Tenn.
Stiver, C. C., Scale Insp., B. & O. R. R., Garrett, Ind.
Stone, L. W., Supvr. B. & B., N. Y. C. R. R., Oswego, N. Y.
Storck, E. G., Mast. Carp., P. & R. Ry., Philadelphia, Pa.
Strothers, R. R., Asst. Engr., C. & St. P. M. & O. Ry., St. Paul, Minn.
Strouse, W. F., Asst. Engr., B. & O. R. R., 400 Forest Road, Baltimore.
Stuart, H. B., Struct. Engr., G. T. Ry., Montreal, Que.
Stuart, T. J., Supvr. B. and B., W. Pac. Ry., Elko, Nev.
Sullivan, William, Care Div. Supt., Mo. Pac. Ry., Kansas City, Mo.
Suter, O. M., Supvr. B. & B., I. C. R. R., Chicago.
Swain, G. F., Prof. C. E., Harvard University, Cambridge, Mass.
Swallow, W. A.
Swan, L. W., Supvr. B. and B., L. V. R. R., Easton, Pa.
Swartz, A., Vice Pres., Toledo & Western R. R., Sylvania, Ohio.
Swartz, H. C., Master B. & B., G. T. R., St. Thomas, Ont.
Sweeney, Wm., For. B. and B., C. & N. W. Ry., Green Bay, Wis.
Swenson, P., Supt. B. and B., M. St. P. & S. Ste. M. Ry., Minneapolis.
Sydell, A. C., Chief Draftsman, C. B. & Q. R. R., Chicago, Ill.

Talbott, J. L., Gen'l For. B. and B., A. T. & S. F. Ry., Pueblo, Col.
Tanner, F. W., Insp. M. of W., Mo. Pac. Ry., St. Louis, Mo.
Tanner, S. C., Mast. Carp., B. & O. R. R., Baltimore, Md.
Tattershall, E. R., Supvr. B. & B., N. Y. C. R. R., Malone, N. Y.
Taylor, D. B., Mast. Carp., B. & O. R. R., Garrett, Ind.
Taylor, F. A., Mast. Carp., B. & O. R. R., Cumberland, Md.
Taylor, Herbert, Supvr. B. and B., D. & R. G. R. R., Alamosa, Colo.
Taylor, J. J., Supt. B. & B., K. C. S. Ry., Texarkana, Tex.
Teaford, J. B., Supvr. B. & B., Sou. Ry., Louisville, Ky.
Templin, E. E., For. Carp., P. & R. Ry., Pottsville, Pa.
Tewksbury, D. G., Supvr. B. & B., St. L. I. M. & S. Ry., Gorham, Ill.
Thomas, M. E., Div. Engr., C. & N. W. Ry., Boone, Iowa.
Thomas, T. E., Mast. Carp., B. & O. R. R., Wilmington, Del.
Thompson, C., Supt. Newkirk & Powers Const. Co., Joliet, Ill.
Thompson, C. S., Supt. B. and B., D. & R. G. R. R., Denver.
Thompson, E. E., G. F. B. & B., A. E. R. R., Phœnix, Ariz.
Thompson, F. J., Asst. Supv. B. & B., F. E. C. Ry., St. Augustine, Fla.
Thompson, F. L., Asst. Ch. Engr., I. C. R. R., Chicago.
Thompson, H. C., Div. Engr., N. Y. C. R. R., Weehawken, N. J.
Thomson, J. L., Gen. Insp. B. & B., D. & R. G. R. R., Salt Lake City.
Thorn, J. O., C. B. & Q. R. R., Beardstown, Ill.

Thorn, S. B., Div. For. Bldgs., M. C. R. R., Bay City, Mich.
Tichbourne, W. H., Supvr. B. & B., G. T. Ry., London, Ont.
Todd, R. E., Asst. Engr., C. & N. W. Ry., Madison, Wis.
Toohey, J. E., Gen'l For. B. and B., P. M. R. R., Grand Rapids, Mich.
Trapnell, Wm., V. P. & G. M., H. S. R. R., Romney, W. Va.
Tratman, E. E. R., Editor, Eng. News, Monadnock Blk., Chicago, Ill.
Travis, J. E., Pinehurst, Wash.
Tretheway, Thos., For. B. & B., Sou. Pac. Co., Stockton, Cal.
Troup, G. A., Engr., Govt. Rys., Wellington, N. Z.
Turnbull, T. B., Supt. B. & B., A. A. R. R., Owosso, Mich.
Turner, W. F., Asst. Div. Engr., Sou. Pac. Co., Ogden, Utah.
Tyers, W. J., Supvr. B. & B., G. T. Ry., Belleville, Ont.

Ullery, O. E., Asst. Engr., C. & N. W. Ry., Sioux City, Ia.
Urbutt, C. F., Asst. Engr. C. M. & St. P. Ry., Roland, Idaho.

Van Auken, A. M., Asst. Val. Engr., M. C. R. R., Ypsilanti, Mich.
Vance, W. H., Ch. Engr., La. & Ark. Ry., Stamps, Ark.
Vatter, E. J., For. P. & W., B. & M. R. R., Salem, Mass.
Vaughan, James, Supvr. B. and B., D. & R. G. R. R., Salida, Colo.
Vincent, E. J., For. B. & B., Sou. Pac. Co., Los Angeles.
Von Schrenk, Hermann, Cons. Timber Engr., 4276 Fladd Ave., St. Louis.

Wackerle, L. J., Supvr. B. & B., Mo. Pac. Ry., Osawatomie, Kans.
Wagner, R., Pile Driver For., C. R. I. & P. Ry., Little Rock, Ark.
Waits, A. L., For. B. and B., St. L. I. M. & S. Ry., St. Louis, Mo.
Walker, I. O., Div. Engr., W. & A. R. R., Atlanta, Ga.
Wallenfelsz, J., Mast. Carp., Pa. Lines W., Cambridge, O.
Warcup, C. F., For. W. S., G. T. R., St. Thomas, Ont.
Watson, P. N., Supvr. B. and B., Maine Central R. R., Brunswick, Me.
Webb, Geo. H., Ch. Engr., M. C. R. R., Detroit, Mich.
Wehlen, Charles, Br. Inspr., L. I. R. R., Jamaica, N. Y.
Weir, C. F., Supvr. B. & B., P. M. R. R., St. Thomas, Ont.
Weise, F. E., Chief Clerk, Eng. Dept., C. M. & St. P. Ry., Chicago.
Weldon, A., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
Welker, G. W., Supvr. B. and B., Southern Ry., Alexandria, Va.
Wells, A. A., R. M. and Supvr. B. & B., Sou. Ry., Winston-Salem, N. C
Wells, C. R., Br. For., Sou. Pac. Co., Sacramento, Cal.
Wells, D. T., For. B. and B., O. S. L. R. R., Salt Lake City, Utah.
Wells, L. N., Div. For., B. & M. R. R., Woodsville, N. H.
Wenner, E. R., Supvr. B. and B., L. V. R. R., Ashley, Pa.
Wester, C. A., Div. Engr., Sou. Pac. Co., Dunsmuir, Cal.
Wheaton, L. H., Div. Engr., Intercolonial Ry., Dartmouth, N. S.
Wherren, F. M., Div. For. B. & B., B. & M. R. R., Salem, Mass.
White, F. W., Supvr. B. & B., L. V. R. R., Sayre, Pa.
White, J. B., For. W. S., C. & N. W. Ry., Boone, Ia.
Whitmee, G. Y., For. W. S., P. M. R. R., Grand Rapids, Mich.
Whitney, W. C., Sen. Archt., I. C. C., 58 Judkins St., Newtonville, Mass.
Wicks, Warren, Gen'l For., L. I. R. R., Amityville, N. Y.
Wilkinson, J. M., Supvr. B. and B., C. N. R. R., Van Wert, Ohio.
Wilkinson, W. H., Bridge Insp., Erie R. R., Elmira, N. Y.
Williams, J. C., Supvr., Georgia R. R., Decatur, Ga.
Williams, M. R., Gen. For. B. & B., A. T. & S. F. Ry., Las Vegas, N. M.
Wilson, E. E., Supv. Brgs., N Y C R R, New York City (81 E. 125th St.).
Wilson, J., Supvr. B. & B., G. T. Ry., Hamilton, Ont.
Wilson, M. M. Div. Br. Inspr., Sou. Pac. Co., Los Angeles
Wilson, W. W., Div. Engr., G. C. & S. F. Ry., Galveston, Tex.
Winter, A. E., Asst. Engr., C. St. P. M. & O. Ry., St. Paul.
Winter, J. L., Mast. Carp., S. A. L. Ry., Waldo, Fla.
Wise, E. F., 207 Clay St., Waterloo, Iowa.
Wishart, J. J., Supvr. B. & B., N. Y. N. H. & H. R. R., Boston, Mass.

Witt, C. C., Dist. Engr., I. C. C., 1020 McGee St., Kansas City, Mo.
Wolf, A. A., Dist. Carp., C. M. & St. P. Ry., Milwaukee, Wis.
Wood, J. P., Supvr. B. & B., P. M. R. R., Saginaw, Mich
Wood, J. W., Gen'l For. B. and B., A. T. & S. F. Ry., Fresno, Cal.
Wood, W. E., Dist. Engr., C. M. & St. P. Ry., Chicago.
Wright, C. W., Mast. Carp., L. I. R. R., Jamaica, N. Y.
Wright, G. A., Gen. For. B. & B., Ill. Trac. Sys., Decatur, Ill.

Yappen, Adolph, Dist. Carp., C. M. & St. P. Ry., Chicago.
Yates, J. P., Gen. For. B. & B., N. O. T. & M. R. R., DeQuincy, La.
Yereance, W. B., Cons. Engr., 128 Broadway, New York City.
Young, R. C., Chief Engr., L. S. & I. Ry., Marquette, Mich.

Zenor, D., For. B. & B., L. & A. Ry., Stamps, Ark.
Zinsmeister, E. C., Mast. Carp., B. & O. R. R., Newark, O.
Zorn, J. F., For. B. & B., Pac. Elec. Ry., Los Angeles, Cal.
Zook, D. C., Mast. Carp., Pa. Lines W. of Pitts., Ft. Wayne, Ind.

Total number of members 709.

LIFE MEMBERS.

Austin, C. P., 107 Park St., Medford, Mass.
Bailey, S. D., Mich. Cent. R. R., Detroit, Mich.
Carmichael, Wm., St. J. & G. I. R. R., St. Joseph, Mo.
Carpenter, J. T., 345 No. Bartlett St., Medford, Ore.
Cummin, Jos. H., Bay Shore, N. Y.
Findley, A., 929 Wash. Ave., Portland, Me.
Gooch, C. W., 1325 W. 9th St., Des Moines, Ia.
Green, E. H. R., Texas Midland R. R., Terrell, Tex.
Hanks, G. E., E. Saginaw, Mich.
Hubbard, A. B., 32 Banks St., West Somerville, Mass.
Killam, A. E., Moncton, N. B.
Loughery, E., Gen. For. B. & B., T. & P. Ry., Dallas, Tex.
Lydston, W. A., Swampscott, Mass.
Mackenzie, W. B., C. E., Moncton, N. B.
McLean, Neil, Mast. Carp., Erie R. R., Huntington, Ind.
Mountain, G. A., Ch. Engr., Ry. Com. of Canada, Ottawa, Ont.
Noon, W. M., Miami, Fla.
Parks, Jas., U. P. R. R., Denver, Colo.
Patterson, S. F. (Sec. Emeritus), Concord, N. H.
Porter, L. H., Box 35, Andover, Conn.
Ross, Wm., C. M. & St. P. Ry., Millbank, So. Dak.
Shane, A., Box 71, Indianapolis, Ind.
Snow, J. P., 1120 Kimball Bldg., Boston, Mass.
Stannard, Jas., 1602 Broadway, Kansas City, Mo.
Tanner, Frank, Mo. Pac. Ry., St. Louis, Mo.
Thorn, J. O., C. B. & Q. R. R., Beardstown, Ill.
Wise, E. F., 207 Clay St., Waterloo, Ia.

DECEASED MEMBERS.

Aldrich, G.
Amos, A.,
Andrews, O. H.
Berg, Walter G.
Bishop, Geo. J.
Biss, C. H.
Blair, J. A.
Bowman, A. L.
Brady, James
Cahill, M. F.
Carr, Charles
Causey, T. A.
Clark, W. M.
Cleaveland, H. D.
Costolo, J. A.
Crane, Henry
DeMars, James
Dunlap, H.
Edinger, F. S.
Ewart, John
Fletcher, H. W.
Forbes, Jno.
Foreman, John
Fuller, C. E.
Gilbert, J. D.
Gilchrist, E. M.
Graham, T. B.
Hall, H. M.
Harwig, W. E.
Heflin, R. L.
Henson, H. M.
Hinman, G. W.
Holmes, H. E.
Hubley, John
Humphreys, Thos.
Isadell, L. S.
Johnson, J. E.
Keen, Wm. H.
Lantry, J. F.
Large, C. M.
Larson, G.
Lovett, J. W.
Mallard, C. C.
Markley, Abel S.
McCormack, J. W.
McGehee, G. W.
McIlwain, I. T.
McIntyre, Jas.
McMahon, J.
Mellor, W. J.
Millner, S. S.
Mitchell, J. B.
Mitchell, W. B.
Morgan, I. W.
Morgan, T. H.
Morrill, H. P.
Peck, R. M.
Perry, W. W.
Phillips, H. W.
Powell, W. T.
Reid, G. M.
Renton, Wm.
Reynolds, E. F.
Robertson, Daniel
Schaffer, J.
Schenck, W. S.
Schwartz, J. C.
Soles, G. H.
Spafford, L. K.
Spangler, J. A.
Spaulding, E. C.
Spencer, C. F.
Taylor, J. W.
Thompson, N. W
Tozzer, Wm. S.
Trautman, J. J.
Travis, O. J.
Vandegrift, C. W.
Van Der Hoek, J.
Wallace, T. E.
Walden, W. D.
Welch, E. T.
Wells, J. M.
Wood, W. B.
Worden, C. G.

MEMBERSHIP AND MILEAGE OF RAILWAYS REPRESENTED.

Name of Road and Membership.	Members.	Mileage.
Alabama, Great Southern R. R.,	1	361
J. R. Murray, Tuscaloosa, Ala.		
Alabama & Vicksburg Ry.,	1	313
(Vicksburg, Shreveport & Pac. Ry.)		
E. L. Loftin, Vicksburg, Miss.		
Algoma Central & Hudson Bay Ry.	1	332
R. S. McCormick, Sault Ste. Marie, Ont.		
Ann Arbor R. R.,	1	292
T. B. Turnbull, Owosso, Mich.		
Arizona Eastern R. R.	1	373
E. E. Thompson, Phœnix, Ariz.		
Atchison, Topeka & Santa Fé Ry.,	5	5,968
Julius Froese, La Junta, Colo.		
A. J. James, Topeka, Kans.		
E. McCann, Wellington, Kans.		
John L. Talbott, Pueblo, Colo.		
M. R. Williams, Las Vegas, N. M.		
Atchison, Topeka & Santa Fé Ry. (Coast Lines)	6	2,053
E. E. Ball, Fresno, Cal.		
J. H. Grover, Fresno, Cal.		
W. H. Oliver, San Bernardino, Cal.		
J. F. Parker, San Bernardino, Cal.		
L. T. Seeley, Needles, Cal.		
J. W. Wood, Fresno, Cal.		
Atlanta & West Point R. R. and W. Ry. of Ala.	1	225
O. T. Nelson, Atlanta, Ga.		
Atlantic Coast Line R. R.	2	4,744
M. E. Nelson, Wilmington, N. C.		
J. W. Salisbury, Port Tampa, Fla.		
Baltimore & Ohio R. R. (System)	19	6,627
G. W. Andrews, Baltimore, Md.		
S. H. Blowers, Columbus, O.		
W. S. Bouton, Baltimore, Md.		
Z. T. Brantner, Martinsburg, W. Va		
H. R. Bricker, Baltimore, Md.		
G. S. Crites, Cincinnati, O.		
Chas. Esping, Chicago, Ill.		
R. F. Farlow, Chillicothe, O.		

Name of Road and Membership.	Members.	Mileage.
Baltimore & Ohio R. R. (System). Continued.		
W. T. Hopke, Grafton, W. Va.		
A. T. Humbert, New Castle Jct., Pa.		
E. G. Lane, Cincinnati, O.		
M. A. Long, Baltimore, Md.		
B. S. Mace, Baltimore, Md.		
E. G. Moore, Flatwoods, W. Va.		
J. O. Potts, Baltimore, Md.		
C. C. Stiver, Garrett, Ind.		
W. F. Strouse, Baltimore, Md.		
S. C. Tanner, Baltimore, Md.		
D. B. Taylor, Garrett, Ind.		
F. A. Taylor, Cumberland, Md.		
T. E. Thomas, Wilmington, Del.		
E. C. Zinsmeister, Newark, O.		
Bangor & Aroostook R. R.	2	628
W. E. Alexander, Houlton, Me.		
M. Burpee, Houlton, Me.		
Bessemer & Lake Erie R. R.	1	210
H. H. Harman, Greenville, Pa.		
Boston & Albany R. R.	1	392
E. M. McCabe, Pittsfield, Mass.		
Boston & Maine R. R.,	23	2,302
Cyrus P. Austin (retired), Medford, Mass.		
L. M. Blake, St. Johnsbury, Vt.		
J. E. Buckley, Nashua, N. H.		
J. P. Canty, Fitchburg, Mass.		
S. E. Dufort, Lowell, Mass.		
J. H. Fullerton, Woodsville, N. H.		
A. I. Gauthier, Concord, N. H.		
B. W. Guppy, Boston, Mass.		
Andrew B. Hubbard (retired), W. Somerville, Mass.		
F. J. Leavitt, Sanbornville, N. H.		
William A. Lydston (retired), Swampscott, Mass.		
John Marsh, Lawrence, Mass.		
H. C. McNaughton, Concord, N. H.		
Albert Mountfort, Nashua, N. H.		
A. A. Page, Wilmington, Mass.		
E. F. Palmer, Salem, Mass.		
S. F. Patterson (retired), Concord, N. H.		
B. F. Pickering, Salem, Mass.		
F. M. Pickering, Salem, Mass.		
E. B. Piper, Concord, N. H.		
E. J. Vatter, Salem, Mass.		
L. N. Wells, Woodsville, N. H.		
F. M. Wherren, Salem, Mass.		
Buffalo, Rochester & Pittsburgh Ry.	4	586
F. A. Benz, E. Salamanca, N. Y.		
E. W. Fair, Du Bois, Pa.		
Chas. Scott, E. Salamanca, N. Y.		
G. H. Stewart, E. Salamanca, N. Y.		
Canadian Northern Ry. System	2	9,295
J. A. Crawford, Saskatoon, Sask.		
A. W. Smith, Winnipeg, Manitoba.		
Canadian Pacific Ry.	2	12,917
Frank Lee, Winnipeg, Man.		
D. A. McRae, Lethbridge, Alberta.		

Name of Road and Membership.	Members.	Mileage.
Carolina & Northwestern Ry.	1	133
J. W. Fletcher, Chester, S. C.		
Central of Georgia Ry.	2	1,924
J. M. Fitzgerald, Macon, Ga.		
H. C. McKee, Macon, Ga.		
Central Vermont Ry.,	6	536
G. M. Cota, St. Albans, Vt.		
C. Donaldson, St. Albans, Vt.		
Central Vermont Ry. Continued.		
C. F. Flint, St. Albans, Vt.		
C. R. Lyman, Waterbury, Vt.		
C. H. Schoolcraft, Farnham, Que.		
W. A. Stewart, New London, Conn.		
Chesapeake & Ohio Ry.	7	2,374
T. H. Allen, Hinton, W. Va.		
A. C. Copland, Richmond, Va.		
F. M. Griffith, Covington, Ky.		
Oscar L. Grover, Richmond, Va.		
C. E. Powell, Hinton, W. Va.		
E. J. Rohr, Cincinnati, O.		
J. M. Staten, Richmond, Va.		
Chicago & Eastern Illinois R. R.	1	1,282
A. S. Markley, Danville, Ill.		
Chicago & North Western Ry.,	41	8,102
L. J. Anderson, Escanaba, Mich.		
C. F. Bach, Belle Plaine, Ia.		
H. Bender, Eagle Grove, Ia.		
F. L. Burrell, Fremont, Neb.		
F. M. Case, Belle Plaine, Ia.		
O. F. Dalstrom, Chicago, Ill.		
T. H. Durfee, Huron, S. D.		
W. H. Finley, Chicago, Ill.		
M. J. Flynn, Chicago, Ill.		
G. W. Hand, Chicago, Ill.		
C. Herrig, Wall Lake, Ia.		
John Hunciker, Chicago, Ill.		
T. J. Irving, Boone, Ia.		
J. W. Irwin, Chadron, Neb.		
W. J. Jackson, Winona, Minn.		
Lee Jutton, Madison, Wis.		
C. F. King, Omaha, Neb.		
B. R. Kulp, Antigo, Wis.		
C. A. Lichty, Chicago, Ill.		
J. A. Lorch, Chicago, Ill.		
George Loughnane, Escanaba, Mich.		
C. A. Marcy, Chicago, Ill.		
J. Mellgren, Eagle Grove, Ia.		
W. F. Meyers, Boone, Iowa.		
C. E. Miller, Chicago, Ill.		
J. W. Miller, Chicago, Ill.		
W. H. Mulcahy, Adams, Wis.		
A. K. Potter, Antigo, Wis.		
J. A. S. Redfield, Fond du Lac, Wis.		
R. W. Richardson, Sioux City, Ia.		
M. Riney, Baraboo, Wis.		
J. S. Robinson, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage.
Chicago & North Western Ry. Continued.		
D. Rounseville, Chicago, Ill.		
F. E. Shanklin, Belle Plaine, Ia.		
Wm. Spencer, Norfolk, Nebr.		
W. M. Sterling, Chicago, Ill.		
W. M. Sweeney, Green Bay, Wis.		
M. E. Thomas, Boone, Ia.		
R. E. Todd, Madison, Wis.		
O. E. Ullery, Sioux City, Ia.		
J. B. White, Boone, Ia.		
Chicago, Burlington & Quincy R. R. Co.,	6	9,366
W. E. Elder, Burlington, Ia.		
W. Hurst, Chicago, Ill.		
W. T. Krausch, Chicago, Ill.		
C. J. Scribner, Chicago.		
A. C. Sydell, Chicago, Ill.		
J. O. Thorn, Beardstown, Ill.		
Chicago Great Western R. R.	3	1,496
W. L. Derr, Clarion, Ia.		
H. H. Eggleston, Des Moines, Ia.		
H. A. Elwell, Clarion, Ia.		
Chicago, Indianapolis & Louisville Ry.	1	578
J. M. Caldwell, Lafayette, Ind.		
Chicago, Milwaukee & St. Paul Ry.,	25	10,667
F. J. Auge, Wells, Minn.		
A. J. Buck, Tacoma, Wash.		
E. E. Clothier, Mobridge, S. D.		
H. R. Drum, Mitchell, S. D.		
W. E. Duckett, Minneapolis, Minn.		
Chas. Gradt, Savanna, Ill.		
L. D. Hadwen, Chicago, Ill.		
F. E. King, Minneapolis, Minn.		
N. H. LaFountain, Chicago. Ill.		
W. R. Lanning, St. Maries, Idaho.		
C. F. Loweth, Chicago, Ill.		
T. E. McFadden, Cedar Falls, Wash.		
E. S. Meloy. Chicago.		
R. J. Middleton, Chicago, Ill.		
Edw. Murray, Miles City, Mont.		
J. F. Pinson, Seattle, Wash.		
G. T. Richards, Tomah, Wis.		
William Ross, Milbank, S. D.		
E. L. Sinclair, Marion, Ia.		
C. U. Smith, Milwaukee, Wis.		
C. F. Urbutt, Chicago, Ill.		
Fred E. Weise. Chicago, Ill.		
A. A. Wolf, Milwaukee, Wis.		
William E. Wood, Chicago, Ill.		
A. Yappen, Chicago, Ill.		
Chicago, Rock Island & Pacific Ry.	10	7,657
McClellan Bishop, El Reno, Okla.		
J. P. Copp, Haileyville, Okla.		
S. T. Corey, Chicago, Ill.		
C. H. Eggers, Little Rock, Ark.		
E. R. Floren, Rock Island, Ill.		
A. T. Hawk, Chicago, Ill.		
M. D. Miller, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage.
Chicago, Rock Island & Pacific Ry. Continued.		
R. C. Sattley, Chicago.		
I. L. Simmons, Chicago, Ill.		
R. Wagner, Little Rock, Ark.		
Chicago, St. Paul, Minneapolis & Omaha Ry.	12	1,750
J. G. Bock, St. Paul, Minn.		
A. F. Gilman, St. Paul, Minn.		
J. F. Glasgow, Worthington, Minn.		
Chas. Mines, Emerson, Neb.		
J. D. Moen, Boone, Ia.		
A. G. Rask, Altoona, Wis.		
H. Rettinghouse, St. Paul, Minn.		
Aug. Ruge, Mankato, Minn.		
Chas. Sedmoradsky, Altoona, Wis.		
John Stewart, Spooner, Wis.		
R. R. Strothers, St. Paul, Minn.		
A. E. Winter, St Paul, Minn.		
Chicago, Terre Haute & Southeastern Ry.	2	351
J. Dupree, Crete, Ill.		
J. O. Jewell, Terre Haute, Ind.		
Cincinnati, Hamilton & Dayton Ry., ...	1	621
R. C. Henderson, Dayton, O.		
Cincinnati, New Orleans & Texas Pacific Ry.	2	338
F. J. Conn, Lexington, Ky.		
L. A. Cowsert, Danville, Ky.		
Cincinnati Northern R. R.	1	236
J. M. Wilkinson, Van Wert, O.		
Colorado & Southern Ry., ...	4	1,089
R. W. Beeson, Trinidad, Colo.		
C. W. Fellows, Denver, Colo.		
Harry James, Denver, Colo.		
A. W. Pauba, Denver, Colo.		
Colorado Midland Ry.	1	338
J. Guretzky, Colorado City, Colo.		
Columbia, Newberry & Laurens R. R.	1	75
A. P. Rice, Columbia, S. C.		
Concho, San Saba & Llano Valley R. R.	1	61
R. S. Hull, Temple, Tex.		
Corvallis & Eastern R. R., ...	1	142
F. M. Siefer, Portland, Ore.		
Delaware & Hudson Co., ...	1	909
N. C. Ailes, Albany, N. Y.		
Delaware, Lackawanna & Western R. R., ...	8	981
F. J. Arnold, Scranton, Pa.		
E. J. Barry, Hoboken, N. J.		
G. E. Boyd, Buffalo, N. Y.		
E. Cahill, Binghamton, N. Y.		
C. G. Connolly, Buffalo, N. Y.		
A. McQueen, Scranton, Pa.		
J. E. Ranney, Buffalo, N. Y.		
Jas. Skeoch, Dunmore, Pa.		

Name of Road and Membership.	Members.	Mileage.
Denver & Rio Grande R. R.,	6	2,577
G. W. Kinney, Salt Lake City.		
A. Ridgway, Denver, Colo.		
H. Taylor, Alamosa, Colo.		
C. S. Thompson, Denver, Colo.		
J. L. Thomson, Salt Lake City.		
Jas. Vaughan, Salida, Colo.		
Detroit & Mackinac Ry.	1	434
John Owen, East Tawas, Mich.		
Duluth & Iron Range R. R.	2	197
W. A. Clark, Duluth, Minn.		
B. T. McIver, Two Harbors, Minn.		
Duluth, Missabe & Northern Ry.,	4	356
F. C. Baluss, Duluth, Minn.		
F. N. Graham, Duluth, Minn.		
W. A. McGonagle, Duluth, Minn.		
G. K. Nuss, Proctor, Minn.		
Duluth, South Shore & Atlantic Ry.	1	601
E. R. Lewis, Duluth, Minn.		
Elgin, Joliet & Eastern Ry.	3	770
W. B. Hotson, Joliet, Ill.		
G. H. Jennings, Joliet, Ill.		
A. Montzheimer, Joliet, Ill.		
Erie R. R.	10	2,557
O. F. Barnes, Jersey City, N. J.		
W. O. Eggleston, Huntington, Ind.		
E. F. Gardner, Buffalo, N. Y.		
A. W. Harlow, Huntington, Ind.		
A. J. Horth, Meadville, Pa.		
F. A. Knapp, Jersey City, N. J.		
W. H. Matthews, Hornell, N. Y.		
Neil McLean, Huntington, Ind.		
Roy Pierce, Salamanca, N. Y.		
W. H. Wilkinson, Elmira, N. Y.		
Florida East Coast Ry.	2	746
E. K. Barrett, St. Augustine, Fla.		
F. J. Thompson, St. Augustine, Fla.		
Fort Smith & Western R. R.	1	217
B. F. Beckman, Ft. Smith, Ark.		
Fort Worth & Denver City Ry.	1	454
J. M. Mann, Ft. Worth, Tex.		
Georgia R. R.,	1	307
J. C. Williams, Decatur, Ga.		
Georgia & Florida Ry.	1	325
W. A. Swallow, Augusta, Ga.		
Grand Rapids & Indiana Ry.	2	592
H. M. Large, Ft. Wayne, Ind.		
W. S. McKeel, Grand Rapids, Mich.		
Grand Trunk Ry. System,	16	4,735
W. Cayley, Stratford, Ont.		
J. B. Gaut, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage.
Grand Trunk Ry. System. Continued.		
J. C. Gokey, Richmond, Que.		
J. Henderson, St. Thomas, Ont.		
J. Innes, Hamilton, Ont.		
J. H. Johnston, Montreal, Que.		
G. C. McCue, Ottawa, Ont.		
George A. Mitchell, Toronto, Ont.		
F. P. Sisson, Detroit, Mich.		
Jos. Spencer, Stratford, Ont.		
H. B. Stuart, Montreal, Que.		
H. C. Swartz, St. Thomas, Ont.		
W. H. Tichbourne, London, Ont.		
W. J. Tyers, Belleville, Ont.		
C. F. Warcup, St. Thomas, Ont.		
J. Wilson, Hamilton, Ont.		
Grand Trunk Pacific Ry.	1	3,627
L. H. Wheaton, Dartmouth, N. S.		
Great Northern Ry.	1	8,102
J. A. Bohland, St. Paul, Minn.		
Gulf, Colorado and Santa Fe Ry.	5	1,937
Z. A. Green, Galveston, Tex.		
K. S. Hull, Temple, Tex.		
G. A. Knapp, Galveston, Tex.		
W. G. Massenburg, Beaumont, Tex.		
W. W. Wilson, Galveston, Tex.		
Hampshire Southern R. R.	1	38
W. Trapnell, Romney, W. Va.		
Illinois Central R. R.,	14	4,767
P. Aagaard, Chicago, Ill.		
Chas. Dale, New Orleans, La.		
F. O. Draper, Chicago, Ill.		
C. Ettinger, Chicago, Ill.		
Maro Johnson, Chicago, Ill.		
C. R. Knowles, Chicago, Ill.		
O. W. Lentz, Chicago, Ill.		
R. J. McKee, Freeport, Ill.		
S. P. Munson, Mattoon, Ill.		
W. L. Ratliff, McComb, Miss.		
M. A. Smith, New Orleans, La.		
O. M. Suter, Chicago, Ill.		
F. L. Thompson, Chicago, Ill.		
E. F. Wise (retired), Waterloo, Ia.		
Illinois Traction System	2	425
G. W. Black, Mackinaw, Ill.		
G. A. Wright, Decatur, Ill.		
Imperial Govt. Rys. of Japan	1	
S. Kurokochi, Tokyo, Japan.		
Intercolonial Ry.	2	1,468
Hugh Jardine, Moncton, N. B.		
A. C. Selig, Moncton, N. B.		
International & Great Northern Ry.	1	1,106
H. M. Jack, Palestine, Tex.		
Kansas City, Clinton & Springfield Ry.	1	155
J. B. Browne, Clinton, Mo.		

Name of Road and Membership.	Members.	Mileage.
Kansas City Southern Ry.	3	826
W. W. Casey, Texarkana, Tex.		
C. E. Johnston, Kansas City, Mo.		
J. J. Taylor, Texarkana, Tex.		
Lake Erie & Western R. R.,	4	882
T. O. Andrews, Tipton, Ind.		
R. M. Bowman, Indianapolis, Ind.		
P. P. Lawrence, Tipton, Ind.		
J. N. Penwell, Tipton, Ind.		
Lake Superior & Ishpeming Ry., Munising, Marquette & S. E. Ry.	2	160
August Anderson, Marquette, Mich.		
Roscoe C. Young, Marquette, Mich.		
Lehigh & Hudson River Railway	1	96
J. E. Barrett, Warwick, N. Y.		
Lehigh & New England R. R.	1	296
A. M. Snyder, Pen Argyl, Pa.		
Lehigh Valley R. R.,	11	1,443
E. B. Ashby, New York City.		
Peter Hofecker, Auburn, N. Y.		
J. W. Holcomb, Buffalo, N. Y.		
R. E. James, Hazelton, Pa.		
Judson Joslin, Auburn, N. Y.		
A. E. Kemp, Hazleton, Pa.		
A. L. Reynolds, New York City.		
F. E. Schall, South Bethlehem, Pa..		
L. W. Swan, Easton, Pa.		
E. R. Wenner, Ashley, Pa.		
F. W. White, Sayre, Pa.		
Long Island R. R.	8	399
E. L. Goldsmith, Jamaica, N. Y.		
Wm. G. Hicks, Jamaica, N. Y.		
M. Loeffler, Jamaica, N. Y.		
W. F. O'Connor, Flushing, N. Y.		
E. P. Self, Jamaica, N. Y.		
Chas. Wehlen, Jamaica, N. Y.		
W. Wicks, Amityville, N. Y.		
C. W. Wright, Jamaica, N. Y.		
Los Angeles & Salt Lake R. R.	5	1,10[illegible]
D. H. Ashton, Salt Lake City, Utah.		
F. M. Bigelow, Salt Lake City, Utah.		
R. R. Bishop, Salt Lake City, Utah.		
W. C. Frazier, Los Angeles, Cal.		
D. W. Scannell, Salt Lake City, Utah.		
Louisiana & Arkansas Ry.	2	54[illegible]
W. H. Vance, Stamps, Ark.		
D. Zenor, Stamps, Ark.		
Louisville & Nashville R. R. (and Nash. Term. Co.)	12	5,07[illegible]
J. M. Bibb, Birmingham, Ala.		
A. J. Catchot, Ocean Springs, Miss.		
R. O. Elliott, Nashville, Tenn.		
H. R. Hill, Birmingham, Ala.		
Floyd Ingram, Erin, Tenn.		
T. H. King, Knoxville, Tenn.		

Name of Road and Membership.	Members.	Mileage.
Louisville & Nashville R. R. (and Nashville Term. Co.) Continued.		
J. W. Little, Birmingham, Ala.		
A. B. McVay, Evansville, Ind.		
C. M. Roy, Birmingham, Ala.		
Wm. Sheley, Evansville, Ind.		
H. Stamler, Paris, Ky.		
W. G. Stewart, Nashville, Tenn.		
Louisiana & Northwest R. R.,	1	121
T. R. Barger, Homer, La.		
Maine Central R. R.	1	1,206
P. N. Watson, Brunswick, Me.		
Michigan Central R. R.	14	1,800
S. D. Bailey, Detroit, Mich.		
Grant Boyer, Detroit, Mich.		
G. H. Fenwick, St. Thomas, Ont.		
Thomas Hall, St. Thomas, Ont.		
F. J. Hodges, Jackson, Mich.		
Henry A. Horning, Jackson, Mich.		
J. S. Huntoon, Detroit, Mich.		
Andrew Leslie, St. Thomas, Ont.		
A. B. Nies, Jackson, Mich.		
W. H. Sellew, Detroit, Mich.		
E. W. Smith, Detroit, Mich.		
S. B. Thorn, Bay City, Mich.		
A. M. Van Auken, Ypsilanti, Mich.		
Geo. H. Webb, Detroit, Mich.		
Minneapolis & St. Louis R. R.	2	1,646
Ed. Gagnon, Minneapolis, Minn.		
G. S. Kibbey, Minneapolis, Minn.		
Minneapolis, St. Paul & Sault Ste. Marie Ry.	2	4,020
G. A. Manthey, Minneapolis, Minn.		
P. Swenson, Minneapolis, Minn.		
Mississippi Central R. R.	1	150
L. E. Faulkner, Hattiesburg, Miss.		
Miss. River & Bonne Terre Ry.	1	64
C. H. Fake, Bonne Terre, Mo.		
Missouri, Kansas & Texas Lines,	1	3,865
A. S. Clopton, Oklahoma City, Okla.		
Missouri, Oklahoma & Gulf Ry.	1	334
Chas. Harrison, Muskogee, Okla.		
Missouri Pacific Ry. System (including St. Louis, Iron Mountain & Southern Ry.)	31	7,293
E. E. Allard, St. Louis, Mo.		
T. H. Bridges, McGehee, Ark.		
Robert J. Bruce, St. Louis, Mo.		
W. L. Burnett, Eudora, Ark.		
J. E. Byrd, McGehee, Ark.		
L. J. Byrd, Dermott, Ark.		
W. E. Byrd, McGehee, Ark.		
H. W. Clark, Falls City, Nebr.		
A. H. Ferdina, St. Louis, Mo.		
C. Gnadt, Poplar Bluff, Mo.		
W. A. Guire, Lake Providence, La.		

Name of Road and Membership.	Members.	Mileage.
Missouri Pacific Ry. System (including St. Louis, Iron Mountain & Southern Ry.). Continued.		
Lon Graves, Dermott, Ark.		
J. C. Hargrove, McGehee, Ark.		
E. H. Harvey, Montrose, Ark.		
W. Hausgen, Sedalia, Mo.		
E. A. Jackson, McGehee, Ark.		
E. P. Hawkins, McGehee, Ark.		
W. J. Lacy, Poplar Bluff, Mo.		
C. W. Lamb, Pine Bluff, Ark.		
G. W. Land, McGehee, Ark.		
A. D. May, Little Rock, Ark.		
C. E. Redmond, Van Buren, Ark.		
J. V. Reynolds, McGehee, Ark.		
D. L. Roper, Monroe, La.		
C. C. Runyon, Gorham, Ill.		
Wm. Smith, McGehee, Ark.		
Wm. Sullivan, Kansas City, Mo.		
F. W. Tanner, St. Louis, Mo.		
D. G. Tewksbury, Gorham, Ill.		
L. J. Wackerle, Osawatomie, Kans.		
A. L. Waits, St. Louis, Mo.		
Mobile & Ohio R. R.	1	1,122
W. B. Harris, Mobile, Ala.		
Morgan's La. & Tex. R. R. & S. S. Co.,	3	405
A. B. Ashmore, Lafayette, La.		
H. F. Jonas, Houston, Tex.		
H. Slabotsky, Lafayette, La.		
Nashville, Chattanooga & St. Louis Ry.	5	1,230
W. H. Fletcher (Retired), Nashville, Tenn.		
H. P. Hodges, Nashville, Tenn.		
Hunter McDonald, Nashville, Tenn.		
O. M. Sorrells, Atlanta, Ga.		
I. O. Walker, Atlanta, Ga.		
New Orleans & North Eastern R. R.	5	196
L. E. Jones, New Orleans, La.		
O. R. McIlhenny, Laurel, Miss.		
C. H. Shapleigh, New Orleans, La.		
J. S. Sharp, New Orleans, La.		
J. J. Steadham, New Orleans, La.		
New Orleans Great Northern	1	285
F. J. Bourgeois, Bogalusa, La.		
New Orleans, Mobile & Chicago R. R.	1	403
P. K. Lutken, Laurel, Miss.		
New Orleans, Texas & Mexico R. R.	1	287
J. P. Yates, DeQuincy, La.		
New South Wales Government Rys.,	1	3,967
James Fraser, Sydney, N. S. W.		
New York Central R. R.	18	5,032
Willard Beahan, Cleveland, O.		
J. K. Bonner, Rochester, N. Y.		
W. S. Haley, Toledo, O.		
U. S. Hitesman, New York City.		
G. J. Klumpp, Rochester, N. Y.		

Name of Road and Membership.	Members.	Mileage.
New York Central R. R. Continued.		
R. P. Mills, New York City.		
Philip O'Neill, Adrian, Mich.		
Kemper Peabody, N. Y. City.		
W. A. Pettis, Rochester, N. Y.		
R. H. Reid, Cleveland, O.		
E. J. Rykenboer, Rochester, N. Y.		
S. A. Seely, Watertown, N. Y.		
J. L. Soisson, Norwalk, O.		
W. F. Steffens, New York City.		
L. W. Stone, Oswego, N. Y.		
E. R. Tattershall, Malone, N. Y.		
H. C. Thompson, Weehawken, N. J.		
E. E. Wilson, New York City.		
New York, New Haven & Hartford R. R.	18	2,003
C. L. Beeler, New Haven, Conn.		
J. S. Browne, New Haven, Conn.		
Eldridge E. Candee, New London, Conn.		
Elliot E. Candee, Waterbury, Conn.		
H. H. Kinzie, Taunton, Mass.		
A. G. McKay, New Haven, Conn.		
W. V. Lattin, Hartford, Conn.		
E. C. Littlefield, New Haven, Conn.		
Wm. H. Moore, New Haven, Conn.		
E. O. Newton, Danbury, Conn.		
B. P. Phillips, Willimantic, Conn.		
L. H. Porter (retired), Andover, Conn.		
George A. Rodman, New Haven, Conn.		
George T. Sampson, Boston, Mass.		
W. B. Schuessler, Waterbury, Conn.		
D. W. Sharpe, New Haven, Conn.		
J. B. Sheldon, Providence, R. I.		
J. J. Wishart, Boston, Mass.		
New York, Ontario & Western Ry.	1	494
J. H. Nuelle, Middletown, N. Y.		
New Zealand Government Rys.	1	2,717
George A. Troup, Wellington, New Zealand.		
Northern Ry. (Costa Rica),	1	375
M. M. Marsh, Squirres, Costa Rica, C. A.		
Northern Pacific Ry.,	3	6,013
James Hartley, Staples, Minn.		
F. Ingalls, Jamestown, N. D.		
C. S. McCully, Jamestown, N. D.		
Northwestern Pacific R. R.,	1	469
A. A. Robertson, San Rafael, Cal.		
Oakland, Antioch & Eastern Ry.	1	115
W. B. Noland, Sacramento, Cal.		
Oregon Short Line R. R.	26	2,256
E. S. Airmet, Salt Lake City, Utah.		
L. W. Althof, Pocatello, Idaho.		
N. D. Brookhart, Pocatello, Idaho.		
F. P. Cullen, Pocatello, Idaho.		
J. F. Cullen, Pocatello, Idaho.		

Name of Road and Membership.	Members.	Mileage
Oregon Short Line R. R. Continued.		
E. A. Demars, Salt Lake City, Utah.		
I. A. Draper, Pocatello, Idaho.		
Fred Gaunt, Pocatello, Idaho.		
Rupert Hansen, Salt Lake City, Utah.		
C. J. Harris, Roberts, Idaho.		
C. A. Harshbarger, Ontario, Ore.		
J. A. Kelly, Pocatello, Idaho.		
A. H. King, Pocatello, Idaho.		
Roy McRostie, Pocatello, Idaho.		
C. T. Musgrave, Idaho Falls, Idaho.		
R. Newton, Pocatello, Idaho.		
P. E. Parsons, Salt Lake City, Utah.		
E. E. Paterson, Pocatello, Idaho.		
C. G. Pitcher, Pocatello, Idaho.		
S. J. Powell, Ogden, Utah.		
A. W. Robinson, Salt Lake City, Utah.		
R. B. Robinson, Salt Lake City, Utah.		
Parker Shifflet, Pocatello, Idaho.		
Wm. Sorensen, Brigham, Utah.		
A. R. Stevens, Pocatello, Idaho.		
D. T. Wells, Salt Lake City, Utah.		
Pacific Electric Ry.	5	1,047
Alf Brown, Los Angeles.		
B. F. Manley, Los Angeles, Cal.		
D. E. Plank, Los Angeles, Cal.		
J. R. Shean, Los Angeles, Cal.		
J. F. Zorn, Los Angeles, Cal.		
Pennsylvania Lines West of Pittsburgh	9	3,098
Samuel C. Bowers, Steubenville, O.		
Stanton Bowers, Bradford, O.		
B. F. Gehr, Richmond, Ind.		
A. F. Miller, Chicago, Ill.		
D. G. Musser, Wellsville, O.		
H. H. Pollock, Carnegie, Pa.		
W. F. Rankin, Cambridge, O.		
J. Wallenfelsz, Cambridge, O.		
D. C. Zook, Fort Wayne, Ind.		
Pennsylvania R. R.	4	5,379
M. M. Barton (Retired), W. Philadelphia, Pa.		
H. R. Leonard, Philadelphia, Pa.		
Robert McKibben, Altoona, Pa.		
A. W. Reynolds, Jersey City, N. J.		
Pere Marquette R. R.	14	2,262
J. D. Black, Saginaw, Mich.		
Thos. Brown, Saginaw, Mich.		
J. J. Evans, Saginaw, Mich.		
Edw. Guild, Grand Ledge, Mich.		
G. E. Hanks (retired), East Saginaw, Mich.		
C. H. Johnson, Reese, Mich.		
A. L. McCloy, Reese, Mich.		
A. McNab, Holland, Mich.		
Homer Morgan, Greenville, Mich.		
John Robinson, Grand Rapids, Mich.		
J. E. Toohey, Grand Rapids, Mich.		

Name of Road and Membership.	Members.	Mileage.
Pere Marquette R. R. Continued.		
C. F. Weir, St. Thomas, Ont.		
G. Y. Whitmee, Grand Rapids, Mich.		
J. P. Wood, Saginaw, Mich.		
Philadelphia & Reading Ry.	5	1,582
Amos H. Beard (retired), Reading, Pa.		
Franklin Gable, Catawissa, Pa.		
G. M. Hoffman, Shamokin, Pa.		
E. G. Storck, Philadelphia, Pa.		
E. E. Templin, Pottsville, Pa.		
Pittsburgh & Lake Erie R. R.	1	224
D. L. McKee, McKee's Rocks, Pa.		
San Antonio & Aransas Pass Ry.	2	724
F. W. Bailey, Yoakum, Tex.		
J. D. Lacy, Houston, Tex.		
Seaboard Air Line Ry.	5	3,449
B. B. Christy, Tallahassee, Fla.		
W. J. Galloway, Hamlet, N. C.		
W. A. McDearmid, Charleston, S. C.		
J. C. Nelson, Norfolk, Va.		
J. L. Winter, Waldo, Fla.		
St. Joseph & Grand Island Ry.	1	258
Wm. Carmichael, St. Joseph, Mo.		
St. Louis & San Francisco R. R.	1	4,740
F. G. Jonah, St. Louis, Mo.		
St. Louis Southwestern Ry.	3	1,685
J. S. Berry, St. Louis, Mo.		
W. V. Parker, Malden, Mo.		
Wm. Quinn, Tyler, Tex.		
Southern Ry.	11	7,022
D. A. Ballenger, Greenville, S. C.		
J. H. Blackwell, Columbia, S. C.		
R. E. Connor, Columbia, S. C.		
N. L. Hall, Greensboro, N. C.		
Joseph A. Killian, Jr., Charlotte, N. C.		
J. S. Lemond, Charlotte, N. C.		
C. A. Redinger, Old Fort, N. C.		
T. E. Sharpe, Greenville, S. C.		
J. B. Teaford, Louisville, Ky.		
G. W. Welker, Alexandria, Va.		
A. A. Wells, Winston-Salem, N. C.		
Southern New England Ry.	4	85
J. E. Cole, Providence, R. I.		
R. D. Garner, Providence, R. I.		
A. Larsen, Millville, Mass.		
W. A. Leach, Providence, R. I.		
Southern Pacific Company	71	6,950
H. L. Archbold, Los Angeles, Cal.		
T. W. Bratten, Oakland Pier, Cal.		
C. W. Brown, Mina, Nev.		
H. Bulger, Oakland Pier, Cal.		
W. H. Burgess, Stockton, Cal.		

Name of Road and Membership.	Members.	Mileage.
Southern Pacific Company. Continued.		
D. Burke, Tucson, Ariz.		
F. L. Burkhalter, Portland, Ore.		
W E. Burns, Portland, Ore.		
J. T. Caldwell, Bakersfield, Cal.		
J. H. Clark, Los Angeles, Cal.		
W. S. Corbin, San Pedro, Cal.		
D. M. Crosman, Los Angles, Cal.		
Geo. Dickson, Oakland, Cal.		
F. C. Dittmar, Los Angeles, Cal.		
R. M. Drake, San Francisco, Cal.		
G. A. Easton, West Oakland, Cal.		
B. F. Ferris, Los Angeles, Cal.		
J. F. Fisher, Sacramento, Cal.		
M. Fisher, Ogden, Utah.		
A. Fraser, Bakersfield, Cal.		
Neil Fraser, Mayfield, Cal.		
P. Fritz, Los Angeles, Cal.		
W. Gaskin, Los Angeles, Cal.		
Ira Gentis, Oakland, Cal.		
P. Giusto, San Francisco, Cal.		
J. A. Given, Sacramento, Cal.		
Jas. Gratto, Los Angeles, Cal.		
C. F. Green, Sacramento, Cal.		
H. A. Hampton, Portland, Ore.		
Robt. Hansen, West Oakland, Cal.		
W. C. Harman, Bakersfield, Cal.		
J. M. Hinchee, Los Angeles, Cal.		
J. A. Hutchens, Ogden, Utah.		
Jno. D. Isaacs, New York City.		
C. A. Jensen, Los Angeles, Cal.		
H. Lodge, San Francisco, Cal.		
C. W. McCandless, Ventura, Cal.		
J. C. McClure, Los Angeles, Cal.		
W. H. McCoy, Dunsmuir, Cal.		
D. McGee, Sacramento, Cal.		
A. M. McLeod, Oakland, Cal.		
J. B. Malloy, San Francisco, Cal.		
J. D. Mathews, Tucson, Ariz.		
F. D. Mattos, W. Oakland, Cal.		
M. J. Mayer, San Francisco, Cal.		
A. T. Mercier, Los Angeles, Cal.		
E. C. Morrison, San Francisco, Cal.		
J. J. Murphy, Oakland, Cal.		
R. E. Murphy, Bakersfield, Cal.		
P. N. Nelson, San Francisco, Cal.		
Harry Pollard, San Francisco, Cal.		
Homer Pollard, West Oakland, Cal.		
Geo. W. Rear, San Francisco, Cal.		
J. S. Replogle, Oakland, Cal.		
D. B. Rich, Stockton, Cal.		
D. T. Rintoul, Bakersfield, Cal.		
A. L. Robinson, Stockton, Cal.		
Norman Rose, Portland, Ore.		
W. M. Rose, Sacramento, Cal.		
Niles Searls, San Francisco, Cal.		
Fred Secord, Sacramento, Cal.		
G. W. Sedwell, Bakersfield, Cal.		
T. H. Settle, Los Angeles, Cal.		
C. W. Smith, Portland, Ore.		

Name of Road and Membership.	Members.	Mileage.
Southern Pacific Company. Continued.		
Thos. Tretheway, Stockton, Cal.		
W. F. Turner, Ogden, Utah.		
E. J. Vincent, Los Angeles, Cal.		
A. Weldon, Bakersfield, Cal.		
C. R. Wells, Sacramento, Cal.		
C. A. Wester, Dunsmuir, Cal.		
M. M. Wilson, Los Angeles, Cal.		
South Manchuria Ry.,	1	10,000
Y. Maruyama, Dairen, Japan.		
Texas & Pacific Ry.	1	1,944
E. Loughery, Dallas, Tex.		
Texas Midland R. R.	1	125
E. H. R. Green, Terrell, Tex.		
The Thousand Islands Ry.	1	20
H. A. Cooper, Gananoque, Ont.		
Toledo, Peoria & Western Ry.	1	248
J. H. Markley, Peoria, Ill.		
Toledo Railways & Light Co.,	1	110
A. Swartz, Sylvania, O.		
Trinity & Brazos Valley Ry.	1	466
B. M. Hudson, Teague, Tex.		
Union Pacific System	1	7,825
J. Parks, Denver, Colo.		
Union Traction Co. of Ind.	1	460
Jno. Hancock, Anderson, Ind.		
Wabash R. R.	3	2,519
A. O. Cunningham, St. Louis, Mo.		
E. C. Danes, Peru, Ind.		
William S. Danes, Peru, Ind.		
Washington Terminal Co.,	1	53
W. M. Cardwell, Washington, D. C.		
Western & Atlantic R. R.	1	137
D. E. Counts, Dalton, Ga.		
Western Australia Government Rys.	1	1,943
E. S. Hume, Midland Jct., Western Australia.		
Western Pacific Ry.	1	945
T. J. Stuart, Elko, Nev.		
Wheeling & Lake Erie R. R.	3	459
Wm. Mahan, Canton, O.		
W. L. Rohbock, Cleveland, O.		
Yazoo & Miss. Valley R. R.	2	1,370
D. H. Holdridge, Vicksburg, Miss.		
W. Shropshire, Greenville, Miss.		

No. of Railroads Represented,	130	
Total, Members and Mileage,	641	260,933
Members not with Railroads,	68	
Total Membership,	709	

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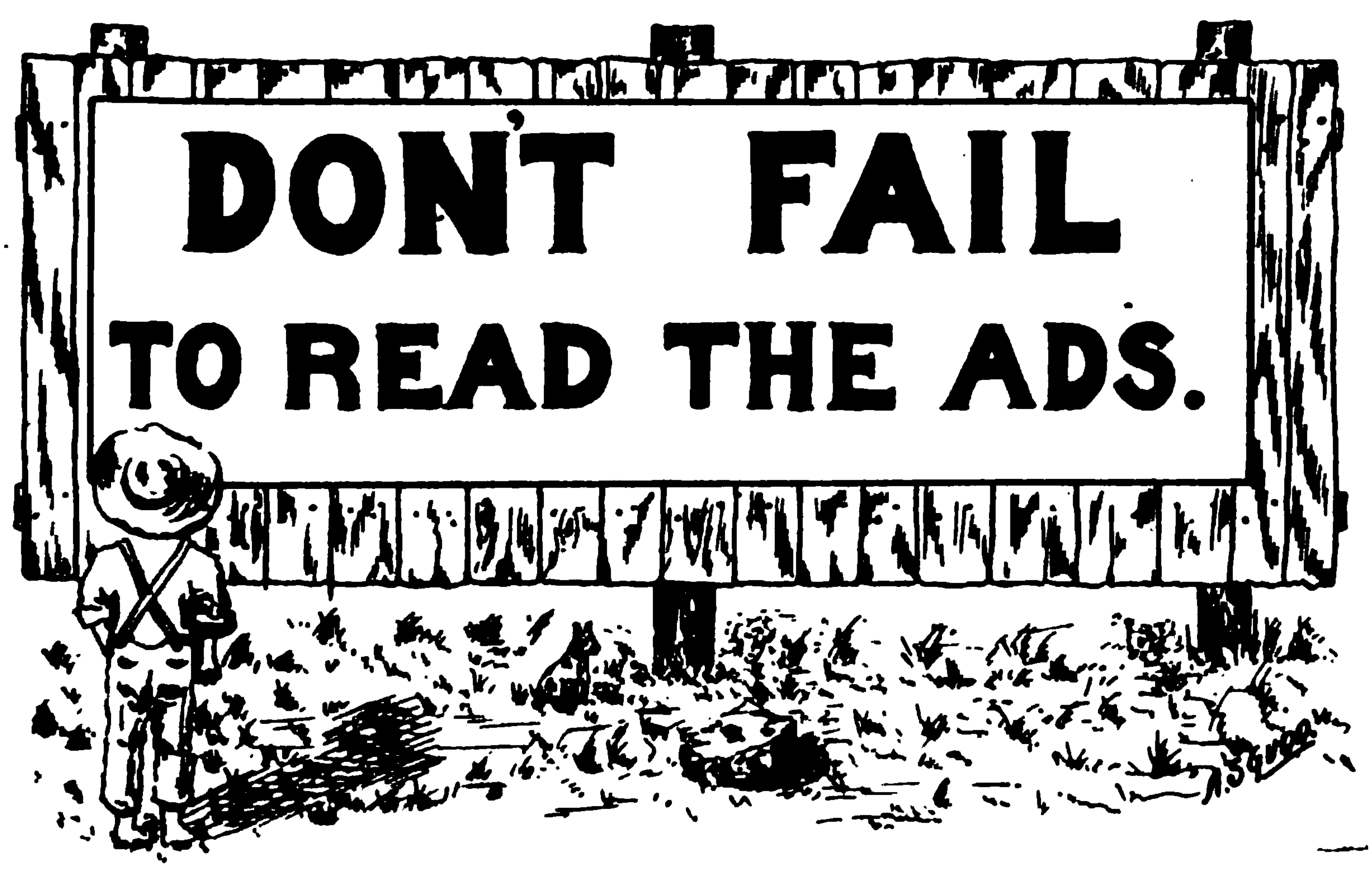

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COMPLETE OUTFIT ON TRUCK with 3 H. P. ENGINE

Every Railroad Division and Department should have one or more of these machines

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Baggage Room Floors

Lehigh Valley Passenger Station, Buffalo, N. Y.
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Sarco

SARCO

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Mineral Rubber Floors
Refrigerator Compound
Damp Proofing M. R. Pipe Coating
Electric Insulation
R. S. A. Specifications
Roofing Materials
Asphaltum Coatings
Expansion Joint Compounds

FILLERS
ROAD MATERIALS
PUTTY
PAINTS

Standard Asphalt & Rubber Co.

208 So. LaSalle Street CHICAGO, ILL.

New Pennsylvania Freight Terminal, Chicago
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A JERRY BOY OUTFIT, as above illustrated, placed in the hands of section foremen will mean a real saving in your Maintenance of Way Department by providing quick transportation of men and material. It will also mean more energy for direct track work from each man.

Winegar, Wis., August 14, 1916

Gentlemen:

Have been using Jerry Boy Engine for over four years and it is still in good condition. The only repairs during that time have been a couple of valves and some packing The largest load I hauled with it was fifteen ties on a push car besides five men and all the tools on hand car. Have been satisfied with engine in every way.

H. BENGS

Sec For C. & N W Ry

Associated Manufacturers Co.

WATERLOO, IOWA

The Q & C Tie Spacer

EVERY Chief Engineer, Bridge Engineer, General Foreman or Foreman of Bridges appreciates the many weak points in the present dapped or lag screwed bridge guard rail. The method of its construction has long been recognized as being imperfect, but no substitute has heretofore been found that has given satisfaction.

The Q & C Tie Spacer, following its successful use on a number of roads, is offered as an economical and thoroughly efficient device, designed to meet the present need under modern conditions, as opposed to the old practice of dapping, etc.

THE Q & C CO.

NEW YORK CHICAGO

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Bridge Slabs Culvert Pipe
Highway and Sewer Pipe
Portable Concrete Houses

for Watchmen, Switchmen and Motor Cars

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CHICAGO	MERIDIAN, MISS.	MEMPHIS
CHATHAM, ONT	ANNA, ILL.	KANSAS CITY

S. C. TANNER
Master Carpenter, B. & O. R. R.
President, 1918

PROCEEDINGS OF THE

Twenty-Seventh Annual Convention

OF THE

American Railway Bridge and Building Association

Successor to the

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS

HELD AT

CHICAGO, ILL.

OCTOBER 16-18, 1917

Official Badge

PRICE ONE DOLLAR

BRETHREN PUBLISHING HOUSE
ELGIN, ILLINOIS
1917

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Chicago, Milwaukee & St. Paul Ry., Chicago.

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C. R. KNOWLES, ... Fourth Vice President
Illinois Central R. R., Chicago.

C. A. LICHTY, ... Secretary-Treasurer
Chicago & Northwestern Ry., Chicago.

THE EXECUTIVE COMMITTEE

Consists of the Officers and the Following Members:

ARTHUR RIDGWAY, Denver & Rio Grande R. R., ... Denver, Colo.

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J. P. WOOD, Pere Marquette R. R., ... Saginaw, Mich.

D. C. ZOOK, Pennsylvania Lines West, ... Ft. Wayne, Ind

A. B. McVAY, Louisville & Nashville R. R., ... Evansville, Ind.

J. H. JOHNSTON, Grand Trunk Ry., ... Montreal, Que.

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SUBJECTS FOR REPORT AND DISCUSSION

1. Repairing and Strengthening Old Masonry.
2. Painting Metal Structures.
3. Water Supply.—
   a. Wooden Water Tanks.
   b. Sources of Supply.
4. Labor Saving Equipment.
5. Small versus Large Gangs for Maintenance Work.
6. Shipping Company Material Economically.
7. Bridge Floors and Guards.
8. Use of Concrete (Small Units).

COMMITTEES

Nominations

R. H. Reid, L. S. & M. S. Ry., Cleveland, O.
J. P. Canty, B. & M. R. R., Fitchburg, Mass.
J. B. Sheldon, N. Y. N. H. & H. R. R., Providence, R. I.

Membership

E. M. McCabe, B. & A. R. R., Pittsfield, Mass.
N. C. Ailes, D. & H. Co., Albany, N. Y.
A. W. Reynolds, P. R. R., Jersey City, N. J.
J. K. Bonner, N. Y. C. R. R., Rochester, N. Y.
A. H. King, O. S. L. R. R., Pocatello, Idaho.

Subjects

F. E. Weise, C. M. & St. P. Ry., Chicago, Ill.
E. T. Howson, Ry. Maintenance Engineer, Chicago, Ill.
C. E. Smith, Consulting Engineer, St. Louis, Mo.

Publications

Lee Jutton, C. & N. W. Ry., Chicago, Ill.
R. C. Sattley, C. R. I. & P. Ry., Chicago, Ill.
P. Aagaard, I. C. R. R., Chicago, Ill.

Arrangements

C. W. Wright, L. I. R. R., Jamaica, N. Y.
R. P. Mills, N. Y. C. R. R., New York City.
A. W. Reynolds, P. R. R., Jersey City, N. J.
O. F. Barnes, Erie R. R., Jersey City, N. J.

Relief

A. Montzheimer E. J. & E. Ry., Joliet, Ill.

Obituary

B. F. Pickering, B. & M. R. R., Salem, Mass.

Proceedings of the Twenty-seventh Annual Convention
of the

American Railway Bridge and Building Association

Held at the Hotel Sherman
Chicago, Ill., October 16-18, 1917

OPENING SESSION

Tuesday, Oct. 16, 1917.

The twenty-seventh annual convention was called to order by the president, C. F. Smith, at 10 a. m., in the Louis XVI room of the Hotel Sherman.

The president announced that the established custom would be followed of opening the meeting with prayer.

Prayer was offered by the secretary, C. A. Lichty.

The President:—Ordinarily, at these conventions, there is an address of welcome and a response as well as an address by the president but on account of the desire to give all of the time possible to the very full program of live topics which are of first importance to the members of the association it was decided to dispense with them and proceed with the business of the convention.

I do not want to allow the opportunity to pass without commenting on the fine attendance of both the members and their families at this meeting. Early in the season quite a few members recommended that the convention be postponed on account of conditions arising out of the war—the principal reason being that but few members might be able to attend. The executive committee wisely set out early to revise the program, dropping some of the subjects of lesser importance and substituting therefor live topics, giving special consideration to the labor and material situation at the present time. You will readily agree that this was the wise plan to adopt as you can see that we have the largest attendance in our history. We have members present from the extremes of Maine, Florida, Texas and

California as well as quite a sprinkling from Canada. There are also eight past-presidents present.

Now I might say that everybody here has undoubtedly been called upon to make sacrifices during the last year that have not been made for many years before,—and while we hope it will not be long until the war will end,—these sacrifices will have to be made for some time to come.

It also comes to me to say that we miss our old friend "Deacon" Patterson who passed away quite suddenly during the last year. He has attended every annual convention up to 1917 and was the secretary from 1892 until 1909. I hope that all who can will attend the memorial service in his honor here tonight.

The next order of business is roll call and as we have the card registration system in effect at the entrance of the convention hall we will dispense with the calling of the roll.

The registration showed the following members present:

P. Aagaard
W. E. Alexander
L. J. Anderson
G. W. Andrews
F. C. Baluss
H. Bender
L. M. Blake
S. C. Bowers
Z. T. Brantner
C. W. Brown
I. B. Browne
R. J. Bruce
J. E. Buckley
F. L. Burrell
W. M. Camp
W. M. Cardwell
W. W. Casey
W. Cayley
J. E. Cole
O. F. Dalstrom
W. L. Derr
I. A. Draper
H. R. Drum
W. E. Duckett
Jas. Dupree
T. H. Durfee
W. O. Eggleston
Chas. Esping
Chas. Ettinger
M. Fisher
C. F. Flint
M. J. Flynn
W. C. Frazier
Frank Gable
J. B. Gaut
B. F. Gehr
C. W. Gooch
Chas. Gradt
F. W. Graham
F. M. Griffith
Edw. Guild
L. D. Hadwen
Thos. Hall
A. W. Harlow
A. T. Hawk
W. G. Hicks
R. C. Henderson
F. J. Hodges
Peter Hofecker
G. M. Hoffman
W. T. Hopke
H. A. Horning
W. B. Hotson
E. T. Howson
A. T. Humbert
Jno. Hunciker
J. S. Huntoon
J. A. Hutchins
W. J. Jackson
A. J. James
G. H. Jennings
J. O. Jewell
C. H. Johnson
Maro Johnson
Lee Jutton
F. E. King
C. R. Knowles
W. J. Lacy
N. H. Lafountain
P. P. Lawrence
A. Leslie
C. A. Lichty
J. A. Lorch
Geo. Loughnane
B. F. Manley
G. A. Manthey
C. A. Marcy
A. S. Markley
S. W. McCaulley
D. L. McKee
W. S. McKeel
Neil McLean
A. McNab
A. B. McVay
E. S. Meloy
W. F. Meyers
A. F. Miller
J. W. Miller
G. A. Mitchell
A. Monzheimer
Homer Morgan
W. H. Mulcahy
D. G. Musser
A. B. Nies
W. M. Noon
G. K. Nuss
P. J. O'Neill
J. F. Parker
B. F. Pickering
J. O. Potts
D. E. Plank
W. F. Rankin
J. A. S. Redfield
R. H. Reid
J. V. Reynolds
G. T. Richards
R. W. Richardson
M. Riney
John Robinson
J. S. Robinson
G. A. Rodman

E. J. Rohr
D. Rounseville
R. C. Sattley
F. E. Shanklin
J. B. Sheldon
I. L. Simmons
E. L. Sinclair
F. P. Sisson
C. E. Smith
L. Spalding
Jos. Spencer
Wm. Spencer
I. M. Staten
W. M. Sterling
W. F. Strouse
H. C. Swartz
W. G. Swartz
W. M. Sweeney
A. M. Swenson
P. Swenson
S. C. Tanner
D. B. Taylor
F. A. Taylor
J. J. Taylor
J. B. Teaford
M. E. Thomas
C. Thompson
R. E. Todd
J. E. Toohey
E. E. R. Tratman
H. von Schrenk
C. F. Warcup
F. E. Weise
J. B. White
J. L. Winter
J. P. Wood
W. E. Wood
C. W. Wright
G. A. Wright
J. P. Yates
R. C. Young
E. C. Zinsmeister
D. C. Zook

The following applicants for membership subsequently elected, were also present:

Edward Collings
John Cronin
O. H. Dickerson
L. H. Douglas
H. A. Gerst
Nels Johnson
A. D. McCallum
Edwd. McGuire
L. A. Mitchell
R. W. Smith
L. Spalding
A. M. Swenson
C. G. Vollmer
C. F. Womeldorf

Total number of members registered, 168.

The President:—Inasmuch as the minutes of the last meeting have been published in the proceedings and placed in the hands of all of the members we will dispense with their reading unless there is some objection. Hearing no objection, the minutes will stand approved.

I will appoint F. E. Weise assistant secretary.

We will now listen to the report of the secretary-treasurer.

REPORT OF THE SECRETARY-TREASURER

The past year has been unusual in many respects. Labor and material conditions have showed a decided unrest and for these reasons the bridge and building departments of all the railroads have had a hard time to get along.

The war has drawn on our number for at least a dozen officers while death has claimed several of our prominent members, among them our faithful secretary emeritus, Mr. S. F. Patterson.

At the last annual meeting St. Paul was voted as the location for the 1917 convention. The executive committee later saw fit to change the location to Chicago which undoubtedly was a wise move.

As far as we have been able to learn the following 7 members have died since our last annual meeting: C. G. Connolly, of the D. L. & W., died Oct. 21, 1916, a few hours after being struck by a switch engine. J. McMahon, of the Grand Trunk, died Nov. 18, 1916, from heart failure after pumping a hand velocipede while overseeing some work. W. M. Clark, of the Baltimore & Ohio, died Jan. 1 from being struck by a passenger train. James Vaughn of the D. & R. G., died March 11, 1917. S. F. Patterson died from pneumonia, in Chicago, April 17, 1917. R. I. McKee, of the Illinois Central, died June 10, 1917, after being struck by a locomotive. Walter Gaskin, of the Southern Pacific, died Aug. 29, 1917, after an operation. At the beginning of the year we had 709 members.

Delinquencies, resignations and death have reduced the number to 682.

Our revenues are dropping each year owing to a decrease in income from advertising and to non-payment of dues.

We issued 1,200 copies of the proceedings of the New Orleans meeting. Three numbers of the Bulletin were published during the year.

Number of members enrolled at close of 1916 convention,	709
Number of deaths during the year,	7
Resignations,	6
Dropped for non-payment of dues,	14
Total number of members at opening 1917 convention,	682

Financial

Balance on hand, last report,		$1,285.88

Receipts.

Dues and fees,	$1,159.00	
Advertising,	1,183.60	
Sale of badges,	23.00	
Sale of books,	59.44	
Interest,	62.00	
Total receipts,		$2,487.04
Total on hand and received,		$3,772.92

Disbursements

Postage,	$ 112.05	
Printing and engraving,	1,238.39	
Stationery and office supplies,	81.88	
Editing,	65.00	
Drafting,	8.40	
Stenographer,	112.50	
Expenses of various committees,	33.76	
Badges,	68.75	
Salaries and office rent,	800.00	
New Orleans Convention expenses,	170.30	
Telephone, telegraph, etc.,	4.00	
Charity,	100.00	
Miscellaneous,	20.10	
Total disbursements,		2,815.13
Balance on hand Oct. 15, 1917,		$ 957.79

Of the above amount $800 is out on first mortgage notes and the balance of $157.79 is on hand in the bank.

The report was adopted and placed on file. The president appointed J. S. Robinson, W. F. Strouse and P. Swenson a committee to audit the books of the secretary-treasurer.

The chair also appointed a committee on resolutions consisting of B. F. Pickering, Lee Jutton and L. D. Hadwen.

The President:—We will next take up the report of the committee on membership.

REPORT OF MEMBERSHIP COMMITTEE.

The membership committee issued the following circular, which, with a small leaflet containing information, was sent out to prospective members:

Dear Sir:—

The American Railway Bridge and Building Association cordially invites you to become a member of that Association. Your name has been suggested to the Membership Committee and we feel that you should make application for the following reasons:—

B 1. You are eligible.
E 2. The Association needs you.
C 3. You need the Association.
A 4. Co-operation with men engaged in work similar to yours on other railroads and in other parts is a privilege.
U 5. United efforts bring best results.
S 6. At the annual meetings of the Association good fellowship and interesting discussions prevail.
E 7. With every additional loyal member the Association is more effectively able to serve the purpose for which it was organized.

This association was organized 26 years ago by practical bridge and building men, with the object of advancing knowledge pertaining to the profession. It provides a clearing house for the exchange of ideas and experiences and as such has proven of great value to its members and the railroads with which they are connected. It is to the Bridge and Building department what the American Railway Engineering Association, the Master Car Builders' Association, etc., are to the other departments, and its usefulness has been recognized and appreciated by the railroads.

The Association has about 700 members among whom are many high officials of railroads who have retained their membership after being advanced. It is felt that there are many others who are eligible to membership but who have not become associated with us, probably from lack of acquaintanceship, and we are taking this means to reach all such, believing that increased membership will be of mutual advantage.

The cost is $5 for membership and the first year's dues, the annual dues thereafter being $2. The Proceedings of the Annual Conventions are published in well-bound book form consisting of about 400 pages; this alone is worth more than the cost of annual dues.

If you will fill out the enclosed application blank and send it to the Secretary, C. A. Lichty, 319 No. Waller Ave., Austin Station, Chicago, you will be elected a member at the next annual convention to be held in Chicago, Oct. 16-18, 1917.

You are also wanted to attend any of our conventions whether you make application for membership or not, the meetings being open to all who are interested in the profession.

Very truly yours,
(Signed by the Committee.)

The president also issued a circular as follows, which was sent to a number of officers of various railroads:

Dear Sir:—

I am writing to suggest to you the desirability of having your bridge engineer, bridge and building supervisors, general water service foremen, etc., become members of this Association. The Am. Ry. Bridge

& Building Association is conducted along the same lines as the Am. Ry. Engineering Association, but treats of the purely practical and constructive side of B. & B. work as differentiated from theory and design. I am convinced that the work done by the B. & B. Assn. is of inestimable value to its members, and to all men interested in B & B. work. The present membership of the Association is about 700.

Committees each year prepare reports which are submitted and discussed at the annual convention, and printed later in the Proceedings. The Proceedings of the last few years contain more practical information in concise form than can be found elsewhere. If a member were to obtain nothing more for his annual dues than the Proceedings he would be fully repaid, and would be a more valuable man to the railroad company.

The dues are nominal. Entrance fee $3, annual dues $2,—$5 with the application blank pays for membership and one year's dues. Enclosed blanks are for distribution among your B. & B. officers who are not now members. It would be a good investment for your company to pay the entrance fees and the first year's dues of such officers as you would like to have join. Additional application blanks will be furnished promptly on request by C. A. Lichty, secretary, 319 No. Waller Ave., Chicago, Ill.

I desire to call your attention to the fact that your road has no representation at present in the membership of our Association. I hope that some of your men can join this year so that your road can secure the benefits of our meetings and proceedings (See note below.)

At a meeting of the executive committee at Chicago a short time ago conclusion was reached to postpone the regular annual meeting scheduled for St. Paul, Oct 16-18, and to hold this year's meeting at Chicago, in order to render it more accessible to the members. It was also decided to eliminate the purely social features and to confine the convention strictly to business, and also to postpone the consideration of some of the routine reports, and to substitute therefor special reports and papers by men specially qualified, covering the conditions as to labor and materials brought about by the war, as it was thought that the consideration of these matters by the members at this time will be of inestimable benefit to the railroads. It is hoped that your company will be well represented at the convention

Yours truly,
C. E. Smith,
President.

(Note: Where roads had only a small representation in the Association, paragraph 4, above, was made to read: "For your ready reference I attach the names of your present officers and employes who are members of the Association. I hope it will be the good fortune of your company and this Assocation that this list be increased.")

Despite the fact that it was a difficult year, for various reasons, to solicit new member the committee, with the assistance of the president, secretary and other members, is pleased to submit the following list of applicants for your approval and election to membership

J. D. Moen,
G. A. Manthey,
A. S. Clopton,
A. W. Reynolds,
A. J. James,
A. W. Smith,
Frank Lee,
Frank Ingalls,
Committee.

LIST OF APPLICANTS FOR MEMBERSHIP

Ballard, C. F., Carp. For., S. A. L. Ry., Peachland, N. C.
Brooks, G. E., Mast. Carp., C. R. I. & P. Ry., Rock Island, Ill.
Brown, E. H., Supv. B. & B., N. P. Ry., Minneapolis, Minn.
Coffin, S. P., Supv. B. & B., B. & M. R. R., Charlestown, Mass.
Collings, Edwd., Chief Carp., C. M. & St. P. Ry., Perry, Iowa.
Cronin, Jno., For. B. & B., C. & N. W. Ry., Winona, Minn.
Dickerson, O. H., Prin. Asst. Engr., D. & I. R. R. R., Duluth, Minn.
Dickson, G. H., Asst. Engr. B. & B., T. & N. O. Ry., North Bay, Ont.
Douglas, L. H., Mast. Carp., B. & O. R. R., Cleveland, O.
Estes, C. F., For. Brdgs., Pac. Elec. Ry., Los Angeles, Cal.
Eubanks, J. E., Br. For., S. A. L. Ry., Yulee, Fla.
Fink, Albert, Gen. For., B. & B., D. L. & W. R. R., Buffalo, N. Y.
Gerst, H. A., Asst. Engr., Bridge Dept., G. N. Ry., St. Paul, Minn.
Gongoll, O. C., Asst. Supt., B. & B., Soo Line, Minneapolis, Minn.
Hayes, J. L., Div. Engr., C. R. I. & P. Ry., Rock Island, Ill.
Heiszenbuttel, H., Genl. For., B. & B., C. & N. W. Ry., Norfolk, Neb.
Johnson, Nels, Supv., B. & B., C. G. W. R. R., St. Charles, Ill.
Jones, Pusey, Act. Engr. Strs., B. & M. R. R., Boston, Mass.
Manson, E. F., Mast. Carp., C. R. I. & P. Ry., Manly, Iowa.
McCallum, A. D., For. W. S., C. H. & D. Ry., Hamilton, O.
McClanahan, S. L., Div. Engr., C. R. I. & P. Ry., Herington, Kans.
McGuire, Edwd., Ch. Carp., C. M. & St. P. Ry., Marion, Iowa.
Mitchell, L. A., Eng. M. of W., U. T. Co. of Ind., Anderson, Ind.
Oldham, W. J., B. & B. Master, T. & N. O. Ry., North Bay, Ont.
Post, J. C., B. & B. For., L. A. & S. L. R. R., Los Angeles, Cal.
Ray, G. T., Supv. B. & B., St. J. & G. I. R. R., Marysville, Kans.
Shields, A. C., Div. Engr., C. R. I. & P. Ry., Trenton, Mo.
Smetters, S. T., Asst. Br. Engr., Sanitary Dist. of Chicago, Chicago, Ill.
Smith, R. W., Gen. For., B. & B., T. & B. V. Ry., Teague, Tex.
Spalding, Lawrence, Supv. Struct., B. & L. E. R. R., Greenville, Pa.
Spell, W. A., Ch. D'ftsman, A. B. & A. Ry., Atlanta, Ga.
Swartz, W. G., Asst. Engr. Const., G. T. R., Campbellford, Ont.
Swenson, A. M., Draftsman, C. R. I. & P. Ry., Chicago, Ill.
Vandercook, Wesley, Ch. Engr., S. A. & S. W. Ry. Sys., Lake Charles, La.
Vollmer, C. G., Ch. Carp., C. M. & St. P. Ry., Elk Point, So. Dak.
Womeldorf, C. F., Asst. Engr., C. & N. W. Ry., Chicago, Ill.

Total number of applicants, 36.

The secretary was authorized to cast the ballot electing the 36 applicants to membership.

REPORT OF EXECUTIVE COMMITTEE

Congress Hotel, Chicago, March 21, 1917.

The meeting was called to order by the president, C. E. Smith. The members present were C. E. Smith, Lee Jutton, F. E. Weise, W. F. Strouse, C. R. Knowles, A. Ridgway, J. P. Wood, D. C. Zook and C. A. Lichty. Several other members of the Association were also in attendance.

The secretary reported on the hotel situation at St. Paul and it was decided that the St. Paul hotel was adapted to our requirements and that negotiations would probably be concluded at an early date.

President Smith explained fully the result of a conference the previous evening with the officers of the American Railway Engineering Association at which was discussed the co-operation or co-ordination of the various railroad organizations with that association and the American Railway Association. Many of the so-called "secondary" associa-

tions were represented by their president or secretary or both. (Several members from this association were present.)

It was voted that we co-operate in the future with the two associations herein named to the extent of conferring from time to time particularly on the list of subjects for committee reports so as to avoid as much as possible duplication of work, etc., keeping in mind the scope of the different organizations and that it be our desire to avoid anything that might compromise or embarrass the other associations or the railway companies.

Mr. Weise recommended that a committee of three be appointed annually hereafter immediately after the annual meeting whose duty it would be to select the list of subjects and present it to the March meeting, and after action by the executive committee proceed with the appointments of the committees on subjects for report and discussion, all of which was to be presented to the following convention for its approval,—the chairman of said committee of three to be the first vice-president.

Meeting adjourned.

Chicago, July 25, 1917.

A meeting of the executive committee was held at the Congress Hotel, Chicago, at 10 a. m. July 25, 1917, pursuant to the call of the president. The members of the committee present were: C. E. Smith, Lee Jutton, F. E. Weise, C. R. Knowles, J. S. Robinson, J. P. Wood, D. C. Zook, and C. A. Lichty. Several other members were present including E. T. Howson and C. Ettinger.

The president stated that the prime object of the meeting was to consider the advisability of postponing the 1917 convention. Letters were read from a number of members, some of whom were in favor of postponing the convention while others were in favor of holding it as usual. Upon first consideration (after some discussion) the committee was unanimous in its decision to hold a convention but it was deemed advisable to change the location of the meeting to Chicago instead of St. Paul, as was voted at the New Orleans convention. It was the consensus of opinion that it would be wise to carry over certain subjects and substitute therefor several live topics bearing on the labor and material situation and other subjects which were of timely interest to our members and the railroads in common in the present crisis.

It was also decided to eliminate most of the entertainment features except for those of the ladies who might be in attendance. A new committee of arrangements was appointed consisting of F. E. Weise, E. T. Howson and the secretary. The committee also voted to remit the dues of all members who are engaged in military service.

Meeting adjourned.

A meeting was called at the close of the Chicago convention, Wednesday, Oct. 18, 1917, at which no other business was transacted than to arrange to send a few engineering journals to our membership in France. Matters pertaining to advertisements were also discussed to some extent.

C. A. Lichty,
Secretary.

REPORT OF COMMITTEE ON RELIEF

Joliet, Ill., Oct. 15, 1917.

The committee on relief has received no requests for aid during the past year with the exception of one from a member who desired a better position.

One of our old members was materially assisted by the road with which he was formerly engaged and was also placed on the pension

roll. A check was also mailed to the same member from the funds of the association.

This association has always taken good care of its members and if at any time members hear of anyone belonging to the association who is in need of relief or looking for a position the committee on relief should be notified promptly.

Respectfully submitted,
Arthur Montzheimer,
Committee on Relief.

REPORT OF THE OBITUARY COMMITTEE

Chicago, Oct. 16, 1917.

To the Members of the Association:

The obituary committee is called upon to report the death of the following members on the dates given herewith:

C. G. Connolly, October 21, 1916; J. McMahon, Nov. 18, 1916; W. M. Clark, January 1, 1917; James Vaughn, March 11, 1917; Samuel F. Patterson, April 17, 1917; R. J. McKee, June 10, 1917; Walter Gaskin, Aug. 29, 1917.

The members of this association feel deeply the loss of their brothers who were faithful to their employers and their families and true and loyal to the American Railway Bridge and Building Association.

Therefore: be it resolved that the sincere sympathy of this association be and is hereby extended to the families of our deceased brothers and that we commend to them the loving kindness and tender mercy of the All-wise Creator who maketh and taketh away, and who is ever the comforter and strength of all who believe in Him.

Be it further resolved that a copy of these resolutions be entered in our proceedings and like copies sent to the families of the deceased members.

Respectfully submitted,
B. F. Pickering,
Committee.

The report of the committee was adopted.

Letters and telegrams were received from numerous members who regretted their inability to be present, but wishing the convention success. Among these were all of our past-presidents who were absent, besides several charter members.

President Smith introduced C. W. Gooch of Des Moines, Iowa, who received an ovation. Mr. Gooch was the first secretary of the association and stated that he well remembers the time when Deacon Patterson submitted his application for membership prior to the Cincinnati convention.

The President:—This completes the preliminary business and we will take up one of the reports of the standing committees before the noon hour.

The first report is "The Economical Delivery of Water to Locomotives." I will ask C. R. Knowles, superintendent of water service of the Illinois Central to come forward and present the report.

C. R. Knowles read the report. (See report and discussion.)

AFTERNOON SESSION

Tuesday, October 16, 1917.

The meeting was called to order by President C. E. Smith at 2:20 p. m.

The President:—The first paper this afternoon is on the subject of "The Erection of Plate Girder Spans with the Least Interruption to Traffic." I will ask Lee Jutton to come to the platform and read the report. This is a very interesting subject and I am sure it will bring out a good discussion.

L. Jutton read the report. (See report and discussion.)

Chas. Ettinger next read a report on "Paint and Its Application to the Exterior of Railway Buildings." (See report and discussion.)

The paper on "Concrete Casing for Steel Structures" was presented by the author, E. E. R. Tratman. (See report and discussion.)

The President:—The last paper on today's program is not a committee report for discussion, but is one that was written by our past president, George W. Rear, on "Snow Sheds." Mr. Rear is connected with the Southern Pacific which runs up through the Sierra Nevada mountains and has had some experience with snow sheds, as you can well imagine. One of the photographs shows snow 80 ft. deep. I am sure this will be a very interesting and valuable addition to our proceedings.

This concludes the program for the afternoon. I wish to remind you of the meeting here tonight in honor of Mr. Patterson.

Meeting adjourned at 5:45 p. m.

MORNING SESSION

Wednesday, Oct. 17, 1917.

The president called the meeting to order at 10 a. m.

The President:—The first item of business this morning will be the report of the nominating committee which will be read by the secretary.

REPORT OF COMMITTEE ON NOMINATIONS

To the members of the American Railway Bridge and Building Association:

After careful consideration the committee on nominations submits the following list of names for officers of this association for the ensuing year:

For president, S. C. Tanner,
First vice president, Lee Jutton,
Second vice president, F. E. Weise,
Third vice president, W. F. Strouse,
Fourth vice president, C. R. Knowles,
Secy-Treas., C. A. Lichty,
Members of the executive committee, A. Ridgway, J. S. Robinson, J. P. Wood, D. C. Zook, A. B. McVay and J. H. Johnston.

Respectfully submitted,
R. H. Reid,
L. D. Hadwen,
J. P. Canty,
Committee.

REPORT OF THE AUDITING COMMITTEE

Chicago, Oct. 17, 1917.

The committee appointed by the president to audit the books of the secretary-treasurer has examined the accounts and found them to be correct as shown in the report submitted to the association.

J. S. Robinson,
W. F. Strouse,
P. Swenson,
Committee.

The President:—The next in order will be the presentation of several letters on " How to Secure and Hold Bridge and Building Men." The secretary will please read the letters. (See letters from F. L. Burrell, J. S. Lemond, J. P. Wood, W. E. Alexander and E. C. Zinsmeister and discussion following.)

After some discussion of the letters President Smith suggested that before continuing it might be advisable to present F. E. Weise's paper on the subject of " Housing and Feeding Bridge and Building Maintenance Crews " in order that the discussion on the two subjects might be carried on jointly. (See report and continued discussion.)

The president gave a short talk on Liberty Bonds, after which there was presented the paper on " Uniform Rates of Pay Versus Differential Rates for Experienced Men " by E. T. Howson. (See report and discussion.)

No paper was presented on " Small Versus Large Gangs for Maintenance Work " and the president suggested that the subject be carried over for next year.

A short report was presented on the subject of " Labor Saving Equipment." The committee complained of the difficulty in getting the information from the railroads to enable it to get out a satisfactory report. (Subject continued.)

The president announced the program for the afternoon meeting when adjournment was taken at 12:20 until 2:00 p. m.

AFTERNOON SESSION

Wednesday, October 17, 1917.

The meeting was called to order by the president at 2:15 p. m.

The President:—The first paper on the program for this afternoon is on the subject of "How Can We Best Meet the Present Bridge and Building Material Situation?" The bridge and structural steel situation is particularly difficult on account of the tremendous demand of the government for steel for ships and war purposes. We are very fortunate in being able to have a paper presented by Albert Reichman, the district manager for the Chicago district of the American Bridge Company, which will bear on that phase of the subject. (See paper by A. Reichman.)

The president announced that the next phase of the subject to be considered was with reference to the lumber situation and that we would hear from H. von Schrenk as regards yellow pine material and from O. P. M. Goss concerning fir lumber from the western coast. (See remarks by Messrs. von Schrenk and Goss.)

C. R. Knowles followed with a paper along the same line with particular reference to Water Service Materials. (See paper.)

Chas. Ettinger was called upon to make some remarks pertaining to the availability of materials for painting.

Some discussion followed, citing instances where material from former bridges and buildings could be overhauled and strengthened and made to take the place of new material where it was impossible to secure new material in the present stringency. (See discussion.)

The secretary presented a short paper on the subject—"Conserving the Supply of Materials by Intelligent Reclamation." (See report and discussion.)

Mr. Camp was called upon for a report of the committee appointed to make recommendations to the association as to what further action should be taken to fittingly memorize Ex-Secretary Patterson.

W. M. Camp:—I want to say that the response from the members who contributed to the remarks made at the memorial service last evening was quite gratifying. We had 22 who made remarks and 22 letters were read. Some more letters have been received, so that so far there have been 46 memorial addresses.

I was not aware, at the time the president appointed this committee, just what was the purpose of it, but I soon found out that

there seemed to be a feeling quite generally throughout the membership that something more should be done to memorialize Ex-Secretary Patterson than what took place at the meeting last night, and many have inquired if some fund could not be provided to erect a monument over his grave.

The subject was brought up last evening in the regular manner, and the committee was authorized to find out what existing monument there was over the grave. We find that there is a family monument there but the family is willing that the association may use a tablet in some way to connect the Deacon distinctly with this association.

The committee has met and discussed the matter, and it would like to know what the association is willing to authorize it to do in this connection. One thing which is sometimes done in tablets, is to cast the features of the deceased in bronze. Mr. Pickering seems to think that perhaps the monument might not be adaptable to such a tablet as we might wish to erect, and that a better arrangement perhaps would be to erect it on the lot over the grave and then, if we have money enough, we could perhaps consider the question of having the features of Mr. Patterson sculptured on the tablet. One member suggested that the tablet be in the form of the shield of the association.

It seems there will be no trouble in getting the necessary funds. A number have expressed a desire to contribute, some $5 and some $10 while practically every member would be willing to contribute a dollar or two. It is the opinion of the committee that this money should be raised by voluntary contributions rather than from the treasury of the association.

I understand his name would properly be inscribed upon the monument and there would be nothing but family remembrances of the Deacon, whereas a good many are desirous that there shall be some memorial which shall distinctly connect the Deacon with this association. The committee would like the sense of the association. I will therefore make a motion that it is the desire of the association that some form of permanent memorial be provided by voluntary contribution.

P. J. O'Neill:—I wish to support that motion, but I think it ought to be a part of the motion that the members not present should have an opportunity to contribute, by sending them notice in the Bulletin or otherwise.

W. M. Camp:—It was in the mind of the committee, that the members not present would be asked if they desired to contribute.

Mr. Camp accepted Mr. O'Neill's amendment to his original motion. The motion, as amended by Mr. O'Neill, was put to a vote by the president and carried.

The President:—I will appoint Messrs. Strouse, Hadwen and Montzheimer a committee of three to circulate among the members and carry out that portion of the motion which applies to the attendance here today.

The contributions were then taken and counted by the committee appointed by the president.

The President:—The next paper is on "Shipping Company Material Economically by Loading Cars to Capacity and Unloading and Releasing Them Promptly." This paper has been written by J. R. Pickering, superintendent of car service of the Rock Island, who is perhaps as well qualified as any man in the country to speak on that subject. In view of the demand of the Government at Washington that cars shall be fully loaded, it is up to the railroad men here to do their part in setting a good example to the public by loading their cars to capacity. In the absence of Mr. Pickering I will ask Mr. Howson to read that paper. (See paper and discussion.)

The President:—The next paper on the subject of "Bridge and Building Material Yards" is directly in line with the discussion of the preceding paper and in the absence of the author, H. C. Pearce, general purchasing agent of the Seaboard Air Line, I will ask the secretary to read the paper. (See paper and discussion.)

G. T. Richards also presented a paper giving the layout and the practice followed by the Chicago, Milwaukee & St. Paul at its extensive yard at Tomah, Wis. (See paper.)

The President:—I do not want to close this session without saying a few words, for it becomes necessary for me to leave Chicago after the banquet tonight for Kansas City on urgent business. I want to thank you all for the way in which you have paid attention and stuck to the business of the convention the last two days which has made it a grand success. I hope it will be my pleasure to meet with you from year to year as time goes on and continue our pleasant relations for I have a very warm spot in my heart for this association. (Applause.)

Meeting adjourned at 5:30 p. m.

MORNING SESSION

Thursday, Oct. 18, 1917.

The meeting was called to order by the first vice president, S. C. Tanner, at 9:45.

The Chairman:—If there is nothing else to come before the meeting at this time we will proceed to the election of officers for the ensuing year.

The secretary will again read the list of names given in the report of the nominating committee.

(The secretary read the list of names.)

G. W. Andrews moved that W. M. Camp be instructed to cast one ballot for the members present, electing as officers those who have been recommended by the committee.

Motion carried and vote cast.

The Secretary:—In the absence of the outgoing president we will ask G. W. Andrews, the oldest surviving past president to come forward and install the newly elected president.

G. W. Andrews:—Mr. Tanner (arising), in behalf of the members who have elected you I ask you to accept the office of president of this association.

(Mr. Tanner accepts.)

Gentlemen, it affords me a great deal of pleasure to introduce to you our newly elected president, S. C. Tanner. This is a pleasure in more ways than one. I have been associated with Mr. Tanner for a number of years. He now is occupying the position on the railroad which I once had the honor of holding and he is now to assume the position of the highest honor which can be bestowed by the members of this grand old association which likewise conferred the honor on your humble servant. If Mr. Tanner makes as good a president as he has made a master carpenter he will serve the association with honor.

The President:—Mr. Andrews and Gentlemen: I wish to thank you for conferring on me the honor of electing me to the highest office in this Association.

I will ask the other members present who were elected as officers to please rise and indicate their acceptance of the positions which they have been called upon to fill.

(The newly elected officers arose and accepted.)

C. W. Wright:—We have had a live worker in our organization in the last year in Mr. Smith, and he has filled the specifications in

every way. He is not present with us this morning, and we didn get a chance to say anything to him, but I would now move you th we extend a vote of appreciation to Mr. Smith for his efficient an able services as president of this association for the past year.

The motion was duly seconded and carried.

The President:—The next item to be brought up for your a tion is the selection of the location for holding the 1918 conventio

Nominations are now in order.

The Secretary:—Before making the nominations for the ne meeting place please permit me to make a few remarks based on th experiences of the year just passed. Many of those present ma not know why the location was changed from St. Paul to Chicag In the early part of the season, after several similar organizatio had decided to abandon their annual meetings, the secretary r ceived numerous letters from our members quite a few of whic were favorable to the abandonment of our meeting for one year least, while others suggested that we carry out the program as usua Several of the prominent members in the vicinity of St. Paul recon mended that we call the meeting off. The secretary wrote the mem bers of the executive committee asking them if they would not fav a one day's session at least in some central location and thus ke the affairs of the association alive as it was observed that some oth similar organizations were carrying out their conventions as in oth years. The replies were nearly all favorable. The result was mad known to the president, C. E. Smith, who called a meeting of the ex ecutive committee, at which meeting nine of the executive membe were present. It was decided to revise the program and to substitu certain subjects that would interest all of our members, the discu sion of which would accrue to the decided benefit of the railroad Mr. Howson assisted the committee materially in all of its unde takings. The wisdom of the decision is left to the judgment of th association after seeing the results of this convention.

What I want to mention in particular is that for some time t come we must not forget to keep in mind the selection of a locatio where the hotel facilities will be ample to provide suitable accomm dations for the attendance is increasing every year. When the lo cation is determined we should be particular to select a hotel whic will be able to provide a suitable convention hall. Several of ou conventions have been held in halls where the noise actually ruin the effect of the sessions.

Now in nominating cities for our next meeting place I thin

it would be wise to keep within range of easy transportation facilities. We ought not to consider places far out of the way at all. We might select a place like St. Paul which location could again be changed by action of the executive committee if war and other conditions made it necessary the same as was done this year. Personally I have no choice. I do not think it would be a mistake to go east next year if not too far.

B. F. Pickering:—I didn't expect to take any active part in the discussion of the question of our next year's meeting place, but some of the gentlemen behind me were going to poke me in the back and I had, for comfort's sake, to get up. (Laughter.)

I think we should take into consideration not only the matter of suitable hotel accommodations in selecting our place of meeting, but under present conditions in our country we should be exceedingly careful in selecting any definite place for the next year's meeting. I was quite amused at our secretary who said that we either ought to select some near-by point, such as St. Paul, or leave it in the hands of the executive committee. Now St. Paul may be a near-by point for Mr. Lichty, but not for Mr. Alexander. However, I quite agree with what our secretary said in regard to making any definite selection. I also think that in justice to St. Paul we should consider their claim very seriously. They have been trying to get us to St. Paul for some time, and this year in the early part of the season it didn't seem possible for us to get that far away, especially on account of the fact that the Government was needing practically all the passenger equipment and train service that the railways could afford through almost every region, and to go off to a point that is not as central perhaps as Chicago, seemed like quite an undertaking. It would overburden perhaps two or three roads, with the vast amount of Government business they are already required to do. Therefore, the selection of Chicago by the executive committee was a wise one, I think, under the conditions.

Now conditions may prevail similar to what they are at the present time next year, but they may also improve very radically. Therefore, I would move you that St. Paul be selected for our meeting place for the convention of 1918, with this provision, that if conditions are such as to make it inadvisable or inexpedient to meet there, on account of war conditions, the executive committee shall select some more central point, not necessarily, perhaps, Chicago, but some point where many railroads center, that the burden may be distributed in taking our members to and from, and also with the

consideration of the hotel accommodations. With that provision nominate St. Paul for our 1918 convention.

The nomination was seconded by A. S. Markley.

G. W. Andrews:—My view of the matter is the same as that pressed by Mr. Pickering. I feel that, in view of the fact that had selected St. Paul for this year's convention, we ought to f that we owe a duty to that city to recognize her rights in the matt and if conditions have improved and the horrible responsibility t is now resting upon our shoulders is removed, we should go to Paul. The proviso of authorizing the executive committee to ta final action is a good one. If conditions such as the present—an am sure not only every man here, but every sober-minded man the world hopes that the great war which is now raging over face of the earth will be removed before that time—are past a we find we can go to St. Paul without question, let us go, but if n the executive committee can select whatever in its good judgme may be the best place to meet the conditions existing at that time.

J. B. Sheldon:—The general impression of the members this association seems to be that the selection of Chicago as a me ing place for this year was a good one, probably for various reaso the principal of which is the transportation question, and, as w suggested by our secretary, it would probably be necessary, in t opinion of a good many, to hold the meeting at some central ra road location next year. The city of Chicago is claimed to be t greatest railroad center of this country,—very much the bigge But there are other points. Take the city of New York. The hea quarters of nearly all of the big railroads are in New York. Almo all of them are governed from there. We have never had a conve tion in the city of New York. We have probably as much or more see there as elsewhere. We have more to see from an engineeri standpoint, and from the standpoint of natural scenery than a other city in the United States. Around Manhattan Island is t greatest aggregation of people on earth. We have engineers, a they have not been idle. Their works are scattered all over Lo Island. We have bridges galore, some of them excelled only perha by the one at Quebec.

We have hundreds of hotels. And if the hotels of New Yo are not able to take care of them at this time of the year there a a dozen or more steamboats tied up at the harbor of New York th are veritable palaces. For the reasons given I nominate the city New York for the next convention.

C. W. Wright:—I would have been pleased to make that nomination myself but I knew Mr. Sheldon could make it much better. I rise to second that nomination. I don't think that the conditions that prevail in other cities are applicable to New York City. I don't think you will have any trouble with hotel accommodations in New York. In fact, the Merchants' Association of New York have promised us the best of accommodations.

Mr. Hadfield:—Mr. Smith told me he would ask that I be given a few seconds to speak about St. Louis. I think you ought to select a central point. I find in the central part of the country, in Chicago particularly, in the City of St. Louis equally so, we are having the maximum attendance. St. Louis and Chicago are both central, and I challenge the statement that we can't have as many members present in St. Louis as in Chicago. I claim it is just as central as Chicago. On the first week in November we will have our new Statler hotel. It will be opened within the next month. We have other hotels, adding altogether about 1500 new rooms, each with a bath, and those hotels are largely booking the conventions. Another thing,—we have some big bridges in St. Louis, and I want to announce that our free bridge is open and working and has been for a number of years. We will have the railroads running over there soon.

W. M. Camp:—We are making entirely too much of a fuss about the place of holding a meeting. Early in the year some of the railway associations, of which there are a good many, got fearful about this matter, and said, " I don't think we will have any attendance to amount to anything,—the railroads are going to be congested,—a lot of the conventions are being abandoned," and a lot more expressions along the same line, and yet, when the Railway Fuel Association met here it had the largest attendance in its history. Last year the Roadmasters had some misgivings about going down to New York. They had been holding all their meetings in Chicago and they were afraid to go down to New York, but they finally did go and they had the largest attendance in the history of their association. This year they came very nearly abandoning the convention, but by one majority in the executive committee they decided to hold it in Chicago and they had the largest attendance in their history, larger than at New York.

I don't think we ought to pay any attention to the bugaboo about small attendance and the lack of transportation facilities. When the railroads can carry thousands forth and back from New York to play baseball, why can't they carry the bridge and building men?

What is more important to the railroads and to this country t to get the railroad men together and have them consider emerge matters that have to be brought into force? If it should hap that a place should be selected and a year from now the railroads congested with the hauling of troops and we can't go to that pl the executive committee has the power to change the place. I th we should go ahead and select a place of meeting just the same.

B. F. Pickering:—I move the nominations be closed and proceed to ballot.

The motion was seconded by Mr. Weise.

The President:—It is moved by Mr. Pickering and seconded Mr. Weise that the nominations be closed and that we proceed ballot. The first nomination by Mr. Pickering was St. Paul, wh was seconded by Mr. Andrews. The second nomination was Mr. Sheldon for New York, which was seconded by Mr. Wrig Mr. Hadfield has given us a nice talk on St. Louis, and of course, thank him for his welcome, and will take that city into considerat with the others.

The President appointed E. T. Howson, Lee Jutton and Ch Ettinger as tellers.

E. T. Howson read the result of the ballot as follows: Cinc nati, 1; St. Louis, 6; St. Paul, 30; New York, 52.

The President:—Gentlemen, you have heard the result of ballot. New York has the majority, and will be our meeting pl for 1918 unless conditions should arise during the year which s gest a change of location.

We will now have the report of the committee on subjects next year.

LIST OF SUBJECTS FOR 1918

1. Repairing and strengthening old masonry (continued).
2. Painting metal structures.
3. Water supply.
4. Labor saving equipment.
5. Small versus large gangs for maintenance work.
6. Shipping company material economically.
7. Bridge floors and guards.
8. Concrete.

F. E. Weise,
Chairman.

F. E. Weise:—I think that perhaps the committee on subjects made a mistake in not presenting a written report as we have in the past. We should have made clear that our list of subjects is very much shorter and briefer than is usually the case. We usually present a list of 11, 12 or 13 different subjects, figuring that one, two or three committees are going to fall down or that it will be impossible to get some committees to handle particular subjects during that year. This year we made the list very brief, including only subjects we thought would be of interest next year, with the intention of recommending to the association that the list be referred to the executive committee, with authority to make such changes as are necessary during the year and to add additional live subjects that would come up during the year, because we don't know what the developments of the near future are going to be.

At this juncture A. S. Markley recommended a subject concerning the handling of work during and after floods, and R. C. Sattley suggested one in connection with valuation work. After some discussion E. T. Howson offered a motion.

E. T. Howson:—Mr. Sattley has just made a suggestion for a subject and Mr. Markley has made another suggestion. There are two subjects up now. There are going to be other things develop during the year. Things move so rapidly that we can't tell now what are going to be the live topics a year from now, just as a year ago we didn't realize what would be the live topics of today. I would move that the report of the committee on subjects, and the suggestions that have been offered, be referred to the executive committee for early action at the same time that the appointment of the committee members is under consideration, and that the executive committee select those subjects which, in its estimation, are those that it would be best for the association to take up, leaving sufficient room for more subjects to be added next spring, when the association will have more definite ideas.

B. F. Pickering seconded this motion. (Motion carried.)

A. F. Miller:—It seems like there is one subject that has never been brought up before the convention, and that is the subject of re-enforced concrete buildings such as engine houses, coal chutes and water tanks. I think that is one of coming materials which we will all have to look to in the near future, and the sooner we get on that the better it will be.

The President:—It is now up to the executive committee to add subjects, or to make any changes it sees fit.

F. E. Weise:—May I say just a word on this matter of su jects? The committee on subjects—and I happen to have been that committee for several years past—finds it a rather difficult ma ter to make up a list of subjects that will bring before the associ tion the things the members want to know the most about, and al the things that will bring about discussions. We have had some su jects we thought were exceptionally good that have brought for no discussion, and others that we didn't think of much consequen have unexpectedly brought forth a flow of discussion. It is rath hard to anticipate that.

It is also hard to know just the subjects the members are inte ested in. Time and again the secretary has asked for suggestion but these suggestions come in very rarely. We will get two, thre four or maybe half a dozen suggestions from a membership of 70 or more. If more of the members would take an interest in th problem and write to the secretary during the year, it would help th committee on subjects. It would also help the secretary and th officers in feeling the pulse of the organization and I think muc could be accomplished in that way.

The Secretary.—I wish to remind you that Mr. Phelps Joh son, president of the St. Lawrence Bridge Company, is a member this association. When we have as important a personage in ou association as Mr. Johnson is, he having completed a task which world famed, in the erection of the Quebec bridge, I think we oug to recognize that honor and have it spread in the minutes of the a sociation.

B. F. Pickering:—I think the point is very well taken. We a at least know something of the great undertaking Mr. Johnson ha been through, and the many discouragements which he has encou tered in the erection of the great Quebec bridge. Therefore, I mov you that a message of congratulation be extended to Mr. Johnso on the success of his great undertaking, showing the appreciatio of this association for one of its member's signal work.

This motion was duly seconded and unanimously carried.

The Secretary:—I would recommend that when we adjourn w visit the exhibits of the supply men in the adjoining room.

It occurs to me that this has been the best convention in ou history, the attendance of members having reached 168. We hav adopted a new plan this year of having the registration table ou side, at the entrance of the hall where dues can be paid and whe

the handling of badges, etc., was conducted. This is a move in the right direction.

The secretary has received valuable assistance from the members during the past year and desires hereby to express his gratitude. We trust that the good work of the association may continue.

J. P. Wood:—I would like to move you that this association extend by a rising vote of thanks its appreciation to the members in the city of Chicago for the able manner in which they arranged for this convention and the way it has been conducted.

The motion carried.

The Secretary:—You were not expecting, from what you were informed in the program, that you were going to receive much entertainment at this convention, but we think it resulted to the decided benefit of the association and the convention, because we have had the best attendance in our sessions in the meeting this year that we have ever had.

L. D. Hadwen:—There have been some years when there has been too much entertainment, and the entertainment which comes upon an intermediate day is always amiss, because when the convention adjourns a forenoon or an afternoon session for an entertainment of some kind it never gets the attendance back again. I believe in holding the business sessions continuously until the business is transacted. I think the committee on arrangements in this city has furnished ample entertainment at this convention.

P. J. O'Neill:—We come here for a specific purpose. Many of the railroads are paying the expenses of the members and they are all allowing the time of their employees who come here. I don't think it is a fair deal to the companies we represent for us to come here to a convention and then spend the time in enjoyment for ourselves. We ought not to do it. We ought to be in this convention hall during all the business meetings of the convention.

J. S. Robinson:—I would like to move that the Supply Men be given a vote of appreciation for the splendid entertainment they have given us.

The motion carried.

REPORT OF THE COMMITTEE ON RESOLUTIONS

Chicago, Oct. 18, 1917.

Resolved:—That the thanks of the Association be extended to the following individuals and corporations:

To the American Bridge Company for furnishing guides and conducting our members through its plant at Gary:

To the New York Central for special service and transportation to and from Gary:

To Sears, Roebuck & Co. for luncheon served our ladies, together with a trip through their plant:

To the Bridge and Building Supply Men's Association for the fine exhibits and for the many courtesies shown our members and their families with special mention of the annual dinner:

To Albert Reichman, O. P. M. Goss, H. C. Pearce and J. R. Pickering for their instructive and helpful papers which are valuable assets to our proceedings:

To the Pullman Company for extending half rates to our members and their families en route to and from our convention:

To the press and the technical journals and their representatives for reporting our convention:

To the officers and the members of the various Committees who so generously contributed their time and efforts to make our work a success.

Be it further Resolved—that these resolutions be spread on our record and the secretary instructed to forward a copy to all parties interested.

Respectfully submitted,

B. F. Pickering,
Lee Jutton,
L. D. Hadwen,
Committee.

The President:—The next in order is adjournment, but before we adjourn I wish to congratulate you all for the fine attendance I have noticed in the present meeting. I also wish to take this opportunity to ask you to bring as many as you can next year and swell the attendance and to do everything possible in the meantime to make the work of this association a success.

We will now adjourn to meet in New York City the third Tuesday in October, 1918, unless conditions require a change of location.

It is so ordered.

L. W. Hoskins,
Reporter.

C. A. Lichty,
Secretary.

MEMOIRS

SAMUEL F. PATTERSON

During the year one of the corner stones in the membership structure of the association has been lost in the death of "Deacon" Patterson. He passed away at Chicago, on April 17, 1917. While traveling from Florida, where he had spent several weeks, to visit friends at River Falls, Wis., he was stricken with ptomaine poisoning and went to a hotel, thinking that his illness was slight; but upon the advice of a physician was taken to the Wesley Memorial hospital, where pneumonia developed and death resulted in about two days.

Samuel Folsom Patterson was born in Contoocook, N. H., January 23, 1840, of Scotch descent, three generations of the family before him

Samuel F. Patterson

having lived in America. His grandfather on the paternal side, Alexander Patterson, was a soldier of the Revolutionary war, in Col. John Stark's regiment, and was wounded in the battle of Bunker Hill. From this ancestor the family tree has been traced back to John Patterson, who was born in Argyleshire, Scotland, about 1640.

Our lamented friend, the "Deacon," began his railroad career as a bridge builder on the Concord & Montreal R. R., before the Civil War, and, except for an intermission during the war, remained in the service of that company, and of its successor, the Boston & Maine R. R., more than 50 years. He was made superintendent of bridges and buildings in 1883, and a few years ago retired from active railroad service on a pension.

He enlisted as a private, in Co. B, 2nd New Hampshire Volunteer Infantry, Sept. 7, 1861, and served the full enlistment of three years. After re-enlistment, in 1865, he was appointed first lieutenant in Co. C in the same regiment. He fought at Seven Pines, Gettysburg and other battles.

Mr. Patterson joined the Association of Railway Superintendents of Bridges and Buildings, at Cincinnati, Ohio, in 1892 At that meeting he was elected secretary of the association and served in that capacity continuously for 17 years, or until 1909. He then, at his own request, was relieved of the active duties of the office, and, by general acclamation, was elected secretary emeritus. While, owing to advancing age, he felt obliged to decline re-election as secretary, at the time stated, he has, nevertheless, attended all of the annual conventions since that time and maintained active interest in the work.

It is fitting here to say that he was not only one of the most popular, but one of the most useful and beloved of men connected with railway association work. He brought to his office a ripe experience as a bridge and building engineer, and his administration of it was always highly efficient. He was the right man in the right place; and it ought to be added that it was largely owing to his practical knowledge of this department of railway work and his untiring efforts, that the association was so well organized in its early years and so strongly upbuilt as time went on.

Owing to his quiet demeanor and ministerial appearance he was familiarly known to his railroad and association friends as "The Deacon"; in fact, this termn of endearment was inseparable from his name. A man of intelligence, most diligent in his business; a great worker in the cause of engineering education; successful, admired, and loved by all, was "Deacon" Patterson.

[At the annual convention, Tuesday evening, Oct. 16, 1917, was set apart specially to memorialize Mr. Patterson. The meeting was well attended, and upwards of twenty members, in short addresses, expressed their appreciation of the life and services of the "Deacon." These addresses were taken down stenographically and with letters from other members not present, will be published in a more complete biography of Mr. Patterson, to be issued as a separate volume by the association.]

CHARLES G. CONNOLLY

Charles G. Connolly, for many years general foreman of bridges and buildings for the Delaware, Lackawanna & Western Railroad, was struck by an engine on the morning of October 21st, 1916. The accident resulted in a serious fracture of the skull and Mr. Connolly lived but a few hours

He was born in Honesdale, Pa., in 1865, and learned his trade in that town. He entered the employ of the Lackawanna in the bridge and building department in 1888, and spent the remaining years of his life in that department. In 1898 he was promoted to foreman and in 1904 to the position of general foreman, being assigned to the Bloomsburg division In 1908 he was made general foreman in charge of the construction of new shops at Scranton, Pa., and from there was transferred to what is known as the Jersey Cut-Off for a short time. In 1912 he was again transferred, this time to the Buffalo division, where he held the position of general foreman until the time of his death.

Mr. Connolly was a very strong character and a man of marked ability. While he was slow to make friends, once a friendship was established it was rarely, if ever, broken. He was connected with many of the large and important pieces of work done by the Lackawanna in the last 20 years and many of the improvements along the line will long stand as a monument to his ability.

He was a brother of John J. Connolly of Honesdale, Pa., Dr. Albert Connolly of Buffalo, N. Y., and the late Rev. William Connolly of Hazelton, Pa. He was also survived by his wife, Mrs. Ella McKeever Connolly.

WILLIAM M. CLARK

William M. Clark was born at Centerville, Pa., on April 13, 1852, and died January 1, 1917, three miles east of Wheeling, W. Va., one-half hour after being struck by an express train. At the time of his death he was on an inspection trip preparatory to the strengthening of the bridges on the Wheeling division to compensate for the increased weight of locomotives and rolling stock. Mr. Clark was in the employ of the Baltimore & Ohio for 35 years, and was a veteran of the old Pittsburgh & Western railroad, having been engaged in building the first bridges and trestles on the latter road. The last 8 years prior to his death he was master carpenter of the Pittsburgh division of the Baltimore & Ohio with headquarters at Pittsburgh.

William M. Clark

Mr. Clark was a member of the Hazlewood Presbyterian Church; he was also a Knight Templar, 32nd degree Mason, a Shriner, an Odd Fellow, and a member of the Royal Arcanum.

He leaves a widow, Alice Coulter Clark, one son and five daughters.

Mr. Clark joined the American Railway Bridge and Building Association at the Detroit convention in 1899, and was a faithful attendant at the meetings—always taking an active interest in the discussions. He attended the New Orleans convention only a couple months prior to his death.

JAMES VAUGHAN

James Vaughn was born at Piqua, Ohio, in 1856, and moved to St. Joseph, Mo., when four years old. He began work with the St. Joseph & Grand Island in 1874 as a helper in the bridge department. In 1877 he entered the service of the Chicago, Burlington & Quincy, and ten years later joined the forces of the Denver and Rio Grande. He was appointed supervisor of bridges and buildings on the latter road in 1898.

Mr. Vaughan died suddenly of apoplexy while on an inspection trip March 11, 1917. He was a resourceful man who made good when conditions were difficult and facilities poor, and was respected by his subordinates and superior officers. He joined the association at its 20th annual meeting in Denver in 1910.

ROBERT JOHN M'KEE

Robert John McKee was born at Pittsburgh, Pa., on March 12, 1861, and died at the St. Francis Hospital, Freeport, Ill., on June 9, 1917, of injuries resulting from being run down by an Illinois Central switch engine while on duty.

From an early date he was associated with construction work, starting as a bridgeman on the Iowa Central Railroad in the spring of 1880, and being promoted to foreman on this road in 1886. After eight years' service in that capacity, with the Iowa Central, he came to Chicago as bridge foreman for the Illinois Central. On July 25, 1895, he was promoted to the office of bridge supervisor of the Springfield division with headquarters at Clinton, Ill. In 1906 he was transferred to the St. Louis division as supervisor of bridges with headquarters at Carbondale, Ill.

Robert John McKee

In 1908 he was transferred to the Freeport division as supervisor of bridges, which position he was holding at the time of his death.

He was a man of noble character and strong personalities, and was much esteemed by all who knew him. His big-heartedness and kindness won him many friends.

Mr. McKee was married to Miss Lucy Draper of Brighton, Iowa, in 1887. He is survived by his wife and four children, Mrs. Gladys Baughman, Freeport, Ill.; Mrs Ocean Hampsher, Washington, Iowa; Mrs. Martha Stout, and Robert J. McKee, Jr., Chicago, Ill.

Mr. McKee was a Knights Templar Mason, being a Past Eminent Commander of Clinton Commandery No. 66, Clinton, Ill., also a member of the American Railway Bridge and Building Association, joining at Quebec on October 20, 1903.

The funeral services were held at the home and were in charge of the Knights Templar Masons of Freeport, Illinois. Interment was made in Hillcrest Cemetery, Brighton, Iowa.

WALTER GASKIN

Walter Gaskin was born in Marysville, California, on July 15th, 1865, and died in the Southern Pacific hospital, San Francisco, on August 29th, 1917, at the age of 52 years, after an illness of several months' duration. He was buried from his residence in Los Angeles. He is survived by his wife and one son.

Walter Gaskin

Mr. Gaskin began his railroad service at the age of 19 years, filling the position as blacksmith with the Central Pacific railroad, now a part of the Southern Pacific System, and with the exception of about six years he has been continuously in the service of the Southern Pacific Company. In July, 1906, he was appointed scale inspector for the Southern district, which position he held at the time of his death. He was a man of sterling character; his genial disposition made him the friend of every one and made every one his friend.

Mr. Gaskin joined the association in 1913.

JOSHUA McMAHON

Joshua McMahon came to his death suddenly Nov. 18, 1917, at Coburg, Ontario, from heart failure caused probably by over-exertion in propelling a one-man velocipede from Port Hope to Coburg, where he went to oversee some work in connection with the construction of a new depot at the ferry dock.

He was in his 58th year and had been connected with the Grand Trunk for 33 years He was one of Port Hope's most esteemed citizens, a kind and sympathetic neighbor and a friend as true as steel. He was a past master of Hope Masonic Lodge and a very active worker in masonry.

Mr. McMahon joined the American Railway Bridge and Building Association at its 23rd annual convention at Montreal in 1913. In addition to his widow he is survived by two sons and four daughters.

THE ERECTION OF PLATE GIRDER SPANS WITH THE LEAST INTERRUPTION TO TRAFFIC

REPORT OF COMMITTEE

It has often been said that the product of railroads is transportation. It has been impressed upon all railroad men that this fundamental principle should always be kept in mind and that they should work for a single purpose of producing transportation in as efficient a manner as possible.

Every railroad man should be interested in the work of his department. In the motive power department every employe should be interested in maintaining locomotives at the highest possible standard for the lowest cost. In the track department every employe should be interested in maintaining the track to the best of his ability. The employes of the accounting department are interested in keeping good accounts and records and in turning out correct statements. This same reasoning can be followed through all the various departments. The employes of each department, while interested primarily in their particular work, should remember that the single purpose of the railroad is to move passengers and freight from one point to another.

The bridge department must keep this fundamental principle in mind at all times in carrying out its work. All bridge work must be planned so as to interrupt traffic as little as possible, remembering that, when trains are stopped on account of a bridge not being ready, a portion of the plant is shut down and the output is stopped until the trains are allowed to proceed. In some cases there is traffic both on and under a bridge which may be under construction. This occurs when a railroad crosses over another railroad, a navigable stream, a busy street or a highway. The problem of maintaining two sources of traffic is often met in the construction of railroad bridges, and of course is more difficult than that of maintaining traffic only over the bridge.

In the erection of railroad bridges under traffic one of two general methods must be selected for each particular case. The old bridge must be taken out in small portions and the new bridge erected in the same manner, or the old bridge must be taken out and the new one put in by handling an entire span in one operation. The first method is most always selected when the traffic over the bridge is quite heavy, making it impracticable to suspend traffic long enough to permit the taking out of an entire span.

There are times, however, when this method cannot be followed even in the case of large structures and on heavy traffic lines. We refer to bridges over navigable streams or over busy railroad tracks. In such cases falsework cannot be put in for the erection of the bridges in sections and some method must be found to put in an entire span at one operation. When bridges are erected by putting in a portion of a span at a time it is necessary to provide a rather large amount of falsework and to arrange this falsework so that the work of changing from the old bridge to the new can be stopped at any point in order to let trains over.

In arranging falsework of this kind it is generally desirable to have

the bents in two sections. The lower section should be constructed so as to support a system of sub-stringers. These should be low enough to clear the lower chords of both the old and the new bridges. The upper section should be constructed so as to be inside of the trusses or girders and to carry the track during the removal of the old bridge and the erection of the new. A good example of the erection of a through plate girder bridge in this way is Fig. 3. This is C. M. & St. P. bridge Z754. In connection with this work the track was raised about 6 ft. 6 in. And this raising of the track was the first work done. The falsework was then put in and all of the blocking removed from the old piers, which left them free for remodeling to suit the new conditions. The falsework provided for a support under each floor beam. This permitted the removal of the old girders and the erection of the new, after which the new floor system was installed gradually as traffic permitted. It was possible at all times to stop work and close the track when necessary to let a train over.

The method of putting in a bridge by changing out one entire span at a time is usually selected when traffic conditions are not severe. It has the great advantage of requiring little or no falsework. As has been mentioned above, however, this method must be used no matter what the traffic conditions are when it is impossible to put in falsework such as over busy navigable streams or railroads. Almost always the new span is assembled and riveted alongside the span it is to replace. This necessitates the erection of one falsework bent at the end of each pier and abutment to receive the new span in its temporary position. This is usually put on the down stream side, although if local conditions require it may be put on the up stream side. Almost always the ties and rails are put on the new span in its temporary position so as to avoid doing that work after the span is moved into its permanent position. Before the new span is moved it is, of course, necessary to dispose of the old span. If time will permit the best method is to cut the old span apart and lift it out with a derrick car. If, however, time will not permit, falsework bents must be erected on the opposite side of the piers and abutments from the new span so that the old span can be moved out to one side preliminary to the moving in of the new span. If the weight of the new span and the capacity of the derrick will permit, the new span should be assembled on the ground at the end of the bridge and then carried bodily into place. The old span, of course, can be removed in the same way. When conditions will permit this method of erection no falsework of any kind is needed.

Fig. 1, showing bridge Z100, of the C. M. & St. P. Ry., illustrates the reconstruction of a deck plate girder structure in which six old spans were combined into three spans for a new bridge. Three new and heavier spans were provided to take the place of the three spans removed. Where the new spans were placed it was necessary to cut down the masonry as the new spans were deeper than the old. The work was carried out by erecting the new spans at one side and by sliding out the old and sliding in the new spans. As shown on the drawing very little falsework was required. This bridge is on a very busy line and there was practically no interruption to traffic.

Fig. 2 shows a method of putting in a double track concrete slab bridge, replacing a timber trestle. The slabs were constructed at one side and were moved into place, one track at a time. These slabs were about 13 ft. by 4 ft. by 36 ft., and weighed 100 tons.

Fig. 4 is a general plan for the erection of deck plate girder spans with ballasted slab floors. This is the usual method of sliding in from one side. The drawing illustrates the use of roller carriages such as are necessary when the span is too heavy to slide on greased rails.

Fig. 5 shows a method of reconstruction of bridge No. 10, on the Detroit division, of the New York Central. At this bridge through plate girder spans replaced a timber trestle. They were erected at one

side and slid into place on greased rails. This is a double track structure and the superstructure for each track is independent of the other track. The superstructure for each track was erected on the side nearest the track in which it was to be used and was moved in from that side.

The erection of bridge No. 142, on the Dakota division, of the C. & N. W. is shown by Fig. 6. In this case a deck riveted span on pile piers was replaced with deck plate girder spans on concrete piers. The girder spans were riveted up on temporary bents on the down stream side of the bridge. When everything was ready the old deck trusses were cut apart, moved up stream and lashed to timbers bolted onto the old pile piers for that purpose. The new spans were then moved into their permanent positions. The time between trains was sufficient to carry out this work without delay to traffic.

Fig. 7 shows a bridge used as an overcrossing of another railroad. In rebuilding this structure it was necessary to maintain the proper clearance for trains on the track below. In maintaining this clearance it was rather difficult to provide bracing for the falsework bents. It was necessary to put in one falsework bent as close as possible to the lower track; then put in the footing of the concrete abutment after which the falsework was completed by erecting a bent on the concrete footing. The superstructure is yet to be erected. This new superstructure is to be a 76 ft. 4 in. through plate girder span. The old bridge is a 44 ft. 3 in. through plate girder span with pile bridge approaches. The new girders will be set on the abutments outside of the old girders. The old span will then be taken out; the new girders moved sideways into their permanent position and the new floor system placed. It will be necessary to interrupt traffic much longer here than would be the case if it were possible to put in falsework under the bridge.

Fig. 8 illustrates a method used at bridge N. 896, on the Peninsula Division of the C. & N. W. Ry. The old bridge consists of deck Howe trusses with pile approaches. The new bridge is a three span deck plate girder structure on concrete piers and abutments. In order to erect the concrete piers it was necessary to cut off the ends of the Howe truss; falsework was arranged to do this. The new spans were put in by removing enough of the old bridge and falsework to permit the erection of one entire span. This was repeated for the three spans.

Fig. 9 shows the method of erection of bridge No. 737, on the Peninsula Division of the C. & N. W. The old bridge consisted of deck riveted span with pile bridge approaches and was replaced with three deck plate girder spans on concrete piers and abutments. Since the new concrete piers came within the limit of the deck trusses it was necessary to arrange the falsework so as to take down the old trusses and to provide space for the construction of the piers. This necessitated the use of two section falsework, the upper part of the lower section being just below the bottom part of the truss spans. This is a double track structure and it was possible to remove the falsework and set one span in place at a time without any severe delays to traffic.

Fig. 10 shows erection of bridge No. B8, on the Eastern division of the C. & N. W. The old bridge consisted of about fifty 60-ft. pony Howe truss spans on pile and frame bent piers. The Howe truss spans were replaced with deck plate girder spans of the same length. The base of rail was raised 3 ft. and the frame bents were cut down to accommodate the new spans. Work was carried out without any falsework whatever. The frame bent piers were cut down to the proper elevation for the new bridge and the Howe trusses were raised at the same time so as to bring the base of rail up to the new elevation. The crew doing this work kept several spans ahead of the crew putting in the girders. Preliminary to putting in a span of girders the stringers and ties on the Howe span to be replaced were removed. The temporary blocking was then taken from under the Howe truss span and the span

lowered onto the new caps. This brought the floor beam of the Howe truss below the lower flanges of the new girders. The floor beams, in this position, afforded first class staging for the men to work on. A span could be changed out in this manner in from two to three hours and the traffic was such that the work could be done without any delay to trains.

Fig. 11 illustrates the erection of bridge No. 259, on the Fort Wayne line. At this bridge a through plate girder span was replaced with a heavier span of the same type. It is a double track structure. The old bridge had three girders to a span whereas the new bridge has only two. The new span was erected complete at one side and when all was ready the old span was removed and the new span put in. Temporary bents were erected on each side of the piers and abutments for this work.

Figs. 14 to 19 inclusive illustrate the erection of a double track through plate girder bridge over a very busy system of railway tracks. This bridge carries the Lackawanna over the Nickel Plate, the Pennsylvania, and the Buffalo Creek Railway. On the three tracks under this bridge there is an average of six train movements per hour. It was therefore necessary to handle these girders from the tracks above. They are 106 ft. long and weigh 103 tons each. It was decided to take the girders off the cars on the approach and run them up endways to their position. The old crossing was at grade and a falsework bridge had been constructed over the entire space to be occupied by the new fill and the new bridge. This falsework bridge was for the purpose of making the fill on the approaches and for the erection of the girders. A set of light girders was used to span the main tracks. A temporary track was constructed along side the filling trestle on one of the approaches. This track was placed at such a height that the girders could be lifted from the cars to the filling trestle. Fig. 14 shows a girder ready to be lifted from the cars. Fig. 15 shows one of the girders after being placed on the filling trestle and ready for movement endwise. Fig. 17 shows the end of one of the girders after it came over the main tracks. Fig. 18 shows one of the girders just before it was placed in its permanent position. Fig. 19 shows the completed bridge. It will be noted that the temporary girders are lashed to the permanent girders to be removed later. These pictures illustrate a rather difficult job which was carried out with very little delay to traffic. It was necessary to set the temporary girders in place from the tracks below and there was some slight delay to traffic in doing this. Otherwise the traffic was not interfered with.

Bridge 160 on the Fitchburg division of the Boston & Maine was rebuilt in 1915 and 1916. This is a double track structure. The old bridge consists of three deck pin trusses and three plate girders. It was rebuilt as three spans of riveted trusses and three spans of deck plate girders. The new bridge was erected on the down stream side. Falsework was placed at the ends of the piers both up stream and down stream. When the erection was completed hoisting engines were placed on the new spans and lines were run from the drums in various directions for the proper movement of the spans. These lines were attached to the up stream side of the piers. The actual time consumed in moving the spans was six minutes. Five spans were put in at one time in this manner. It was necessary to break the tracks for a period of five hours in order to change the track centers from 12 ft. to 13 ft. and for other work in connection with the change in the type of bridge. The sixth span was placed later by a derrick.

When through truss spans are replaced with deck plate girder spans it is almost always possible to set the girder spans inside of the truss spans by cutting down the masonry and removing the lower laterals and floor system of the truss spans. Under proper conditions the girders can be lowered with rigging suspended from the top chords of the old

trusses. This is a very economical method of erection but it can be used only on lines where the traffic is comparatively light. A good example of this method is shown by Figs. 12 and 13, of bridge No. 134 on the Missouri division of the C. R. I. & P. These photographs show the heavier spans being placed by a derrick at either end. The shorter spans, however, were placed by suspending them from the top chords of the old trusses. On the W. & L. E. several through trusses were replaced with deck plate girder spans. A new concrete pier was constructed under the truss span and in most cases the old abutments were remodeled to receive the new girder spans. A specially-arranged derrick car was used in this work. Before the erection of the girders the rivets were removed from the floor system and traffic was carried on bolts. Just before removing the floor system it was necessary to cut the stringers over the new piers by the use of an acetylene torch. The end of the stringers at this cut which were not removed first were blocked up on the pier, after which enough of the floor system was removed and dropped below to permit the erection of one girder span. This span was finished, traffic resumed, and at an opportune time the second girder was erected in much the same way. This left the old span with the lower laterals, floor system and most of upper lateral removed. It was therefore necessary to support the trusses laterally by timber frames securely bolted to the under side of the girder span and extending up on the outside of the old trusses. These frames also furnished the necessary supports for dismantling the old trusses. In doing this work the track was closed to traffic from 1½ to 2 hours. This work is described in detail in Engineering News, Vol. 73, page 491.

We have endeavored to outline the general methods for the erection of plate girder spans with the least interruption to traffic. We have also called attention to specific cases. While one of the general methods can be applied to each bridge erection job, it is necessary to study each case separately and modify the general scheme to fit each individual case.

Lee Jutton (Chairman).
C. W. Wright.
J. S. Huntoon.
J. G. Bock.
C. U. Smith.
S. T. Corey.

Committee.

Fig. 1. Bridge Z-100, Chicago, Milwaukee & St. Paul Ry.

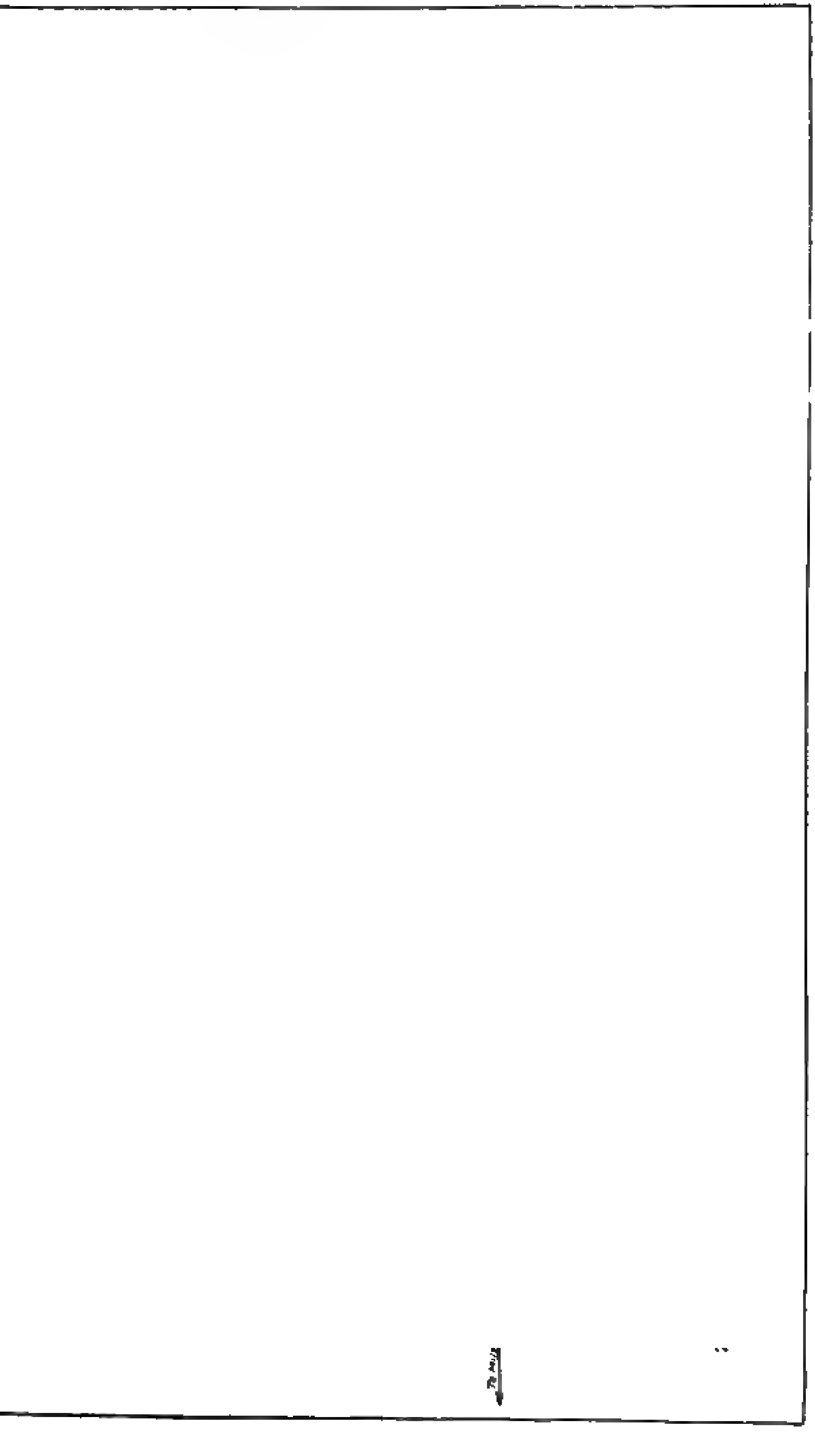


Fig. 2. Bridge A-118 2-3, Chicago, Milwaukee & St. Paul Ry.

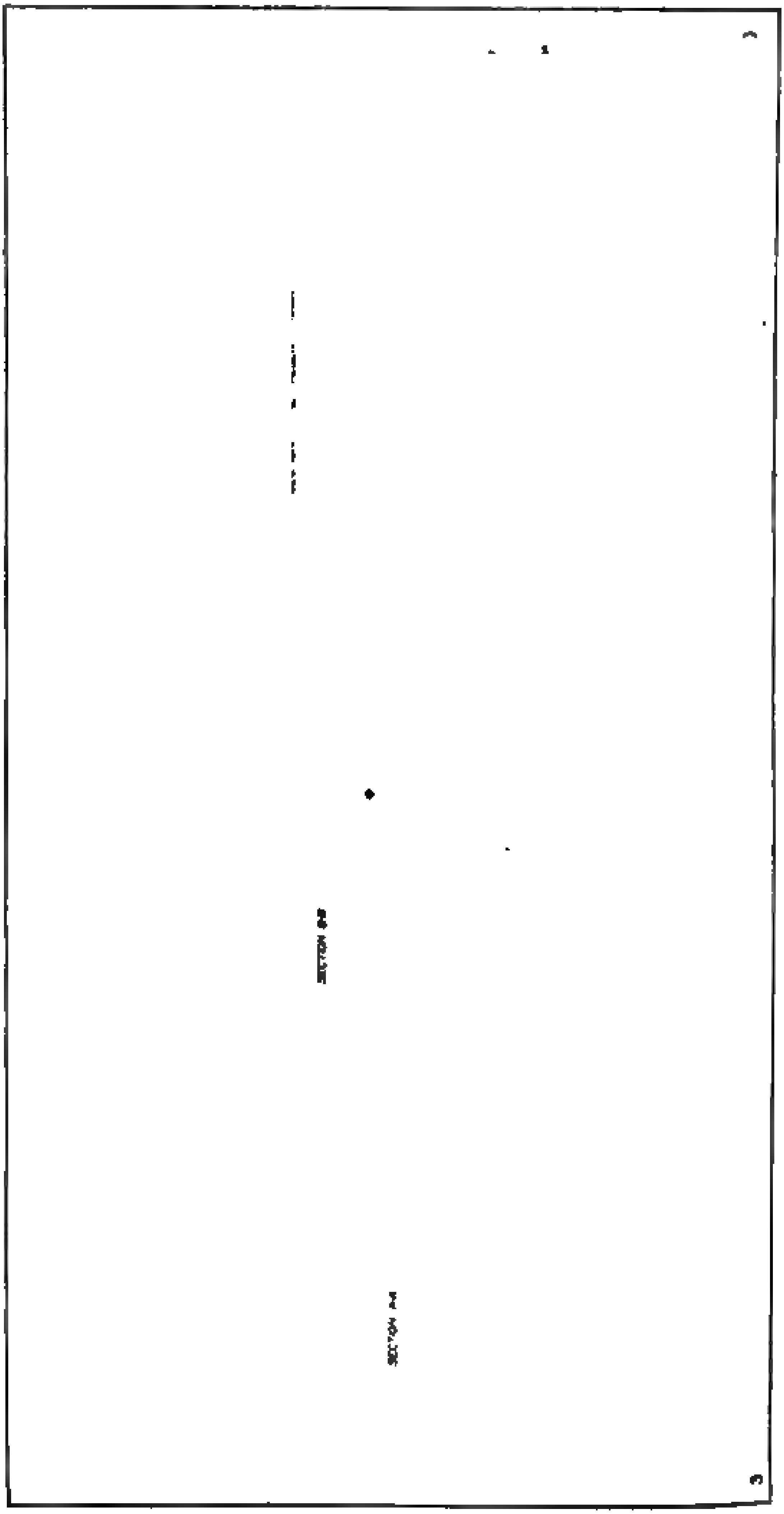


Fig. 3. Bridge Z-754, Chicago, Milwaukee & St. Paul Ry.

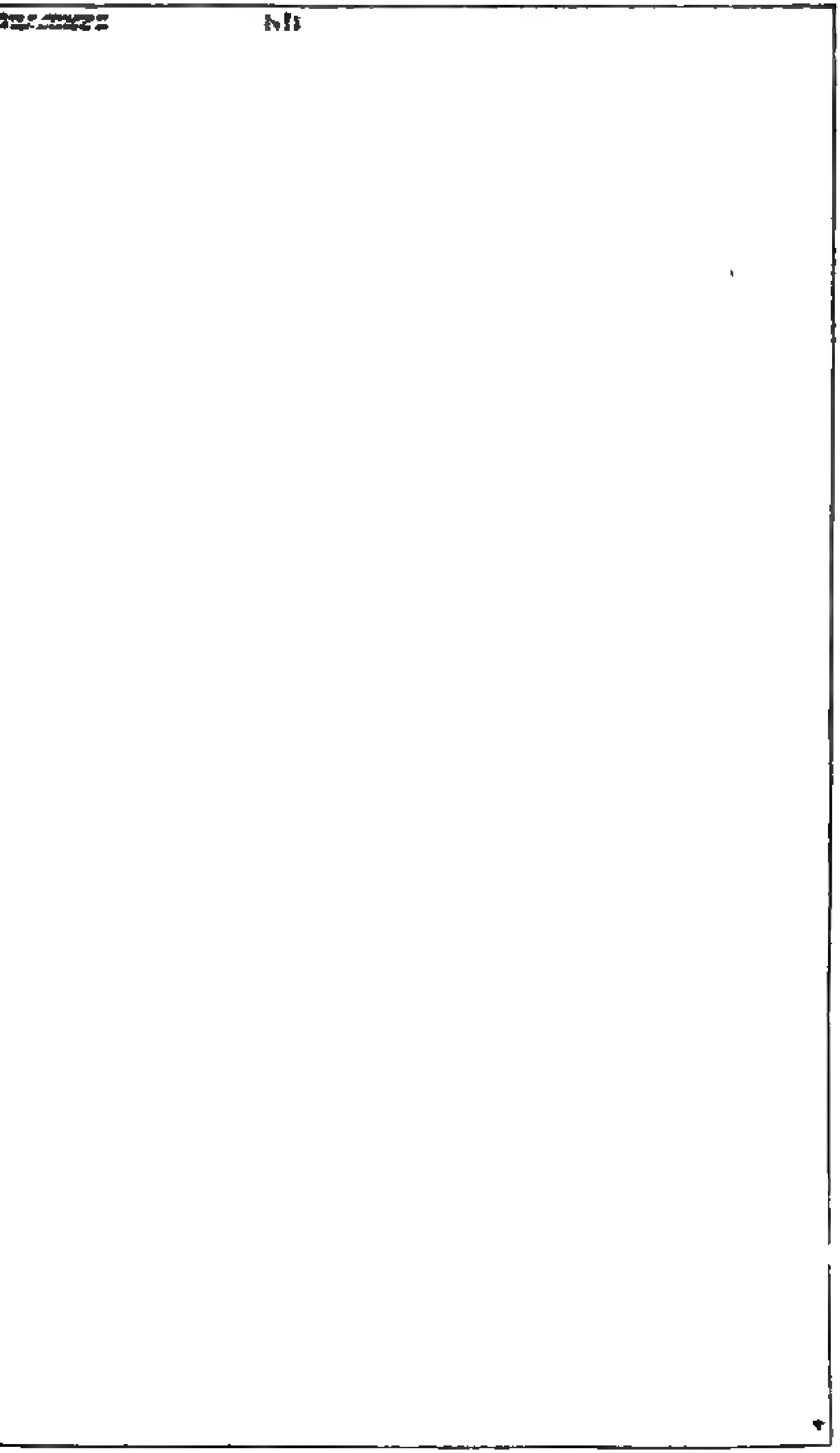
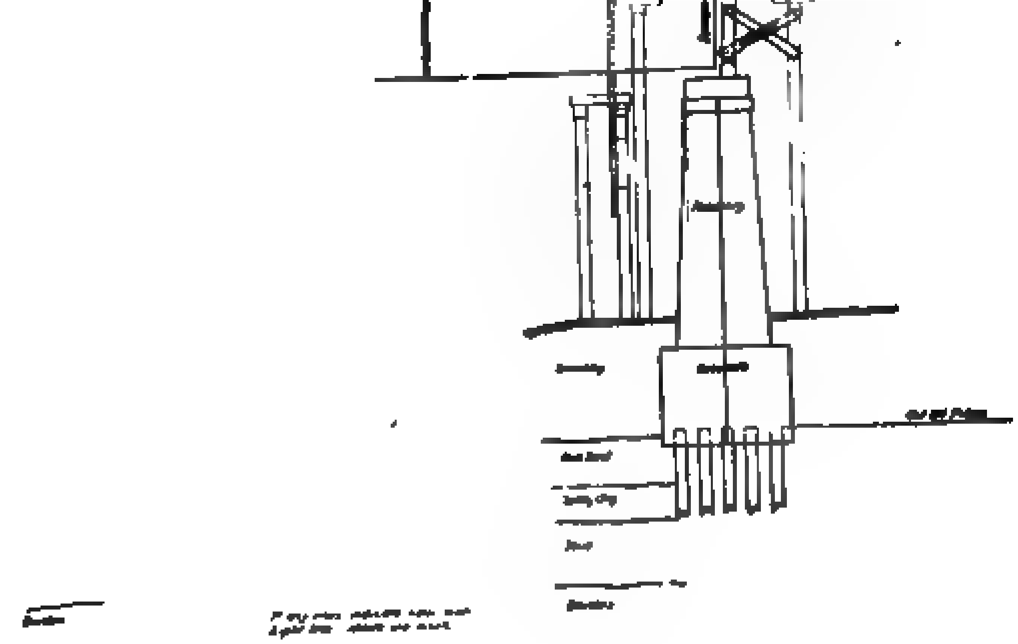


Fig. 4. General Erection Plan, for Ballast Floor Deck Plate Girders, C. M. & St. P. Ry.



ORDER OF WORK

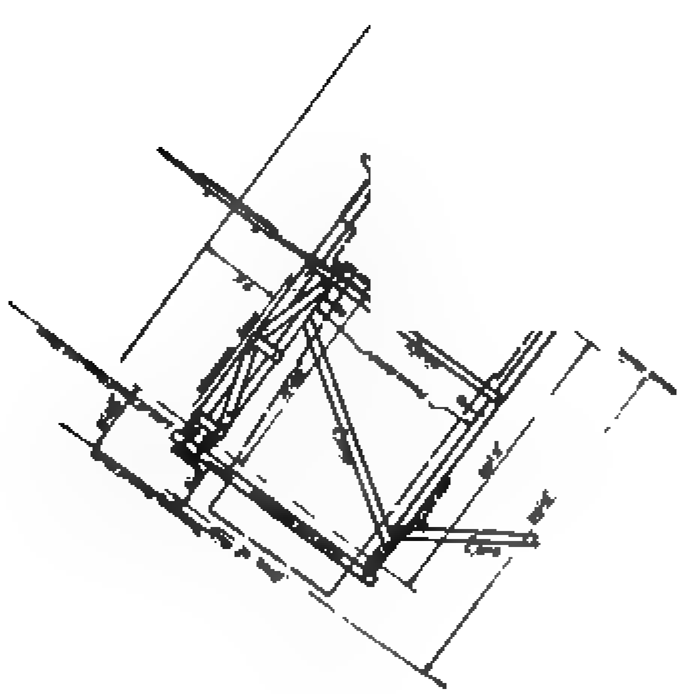
This Falsework is designed for the following order of work.

1 Build masonry piers
2 Drive pile bent at end of each pier and place crossbeams
3 Support all girders on crossbeams opposite their final positions and rivet up all connections Place cast bases on pedestal blocks
4 Remove old floor of end span, cut old trusses apart, and place them side by side on far ends of old piers, lashing them upright to 4"x 10" pieces as shown
5 Jack up girders and place blocking and rails under them, spiking rails to blocking
6 Connect new span on using one of the two permanent pony bents Connect new span and adjoining old span, using temporary bent and second permanent, as shown
7 Replace each span in this way, leaving permanent pony bent on last pier to support connection with pile approach

6

MASONRY AND FALSEWORK PLAN

Fig. 6. Bridge No. 142, Dakota Division, Chicago & Northwestern Ry.



PLAN

Fig. 7. Bridge No. 313, Northern Iowa Division, Chicago & Northwestern Ry.

Fig. 8. Bridge No. 896, Peninsula Division, Chicago & Northwestern Ry.

Fig. 9. Bridge No. 737, Peninsula Division, Chicago & Northwestern Ry.

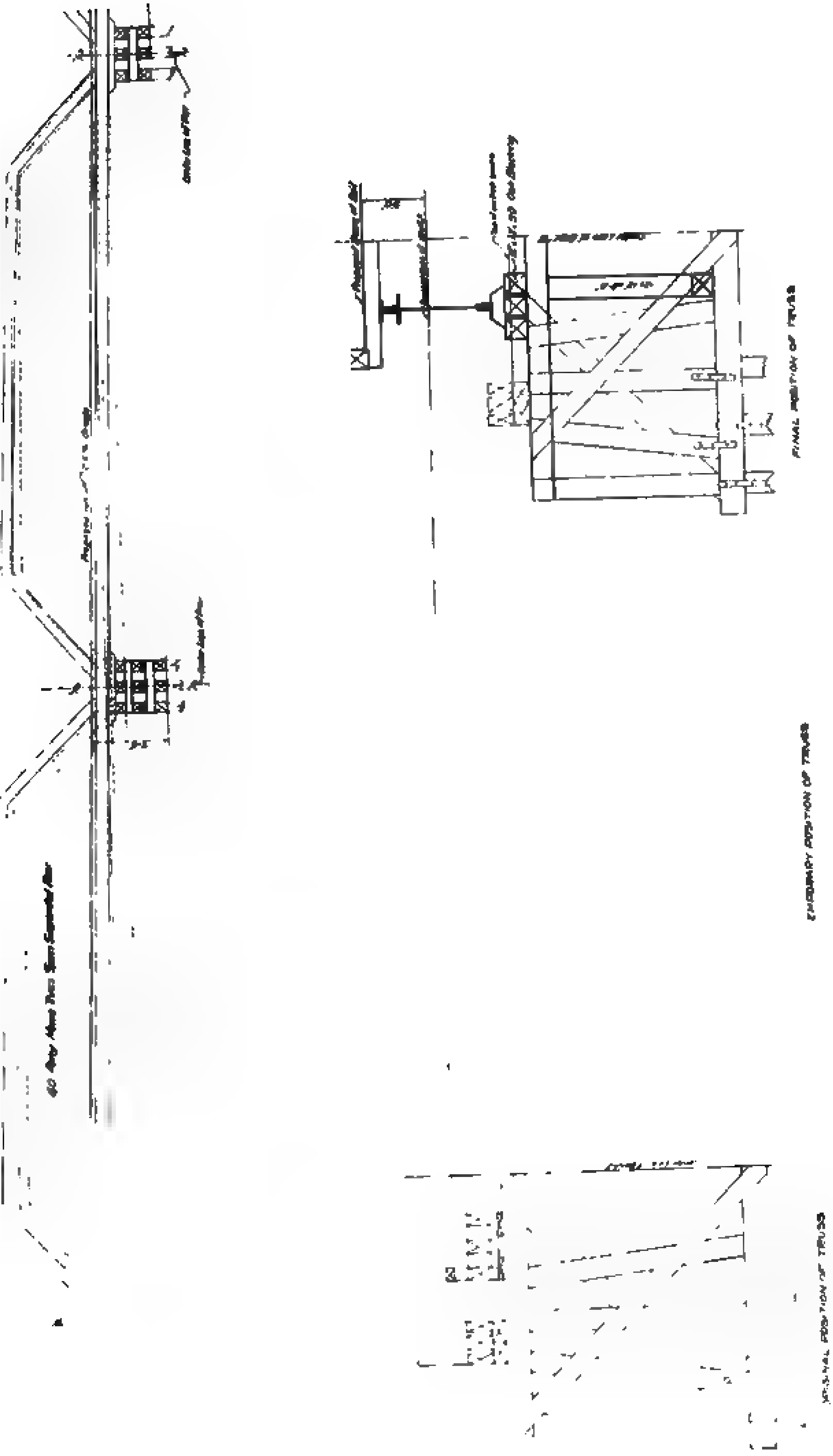
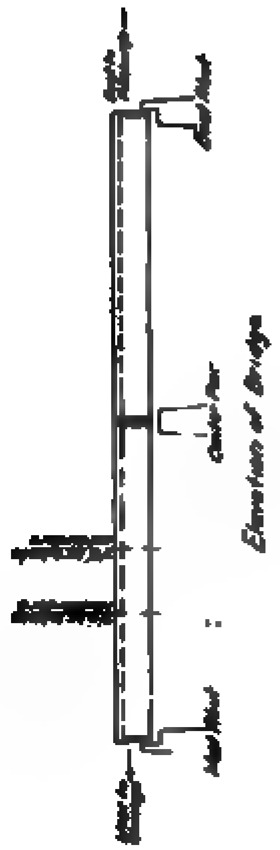


Fig. 10. Bridge No. B.8 Eastern Division, Chicago & Northwestern Ry.



ELEVATION ALONG CENTER LINE OF TRACK

Fig. 11. Bridge No. 209, Pittsburgh, Fort Wayne & Chicago Ry.

Part of Fig. 11, Bridge No. 250, P., F. W. & C. Ry.

Figs. 12 and 13, Bridge 134, Missouri Div., C., R. I. & P. Ry.

Fig. 14

Fig. 15

Fig. 16

Figs. 14, 15, 16. Overhead Bridge, Lackawanna R. R. (See Figs. 17, 18, 19

Fig. 17

Fig. 18

Fig. 19

Figs. 17, 18, 19. Overhead Bridge, P. R. R. and Buffalo Creek R. R.
(See also Figs. 14, 15, 16)

DISCUSSION

The President:—The discussion of this report is now in orde[r]. I am sure there are just as many ideas on the erection of plat[e] girder spans with the least interruption to traffic as there are me[n] in this room. I can pick out a dozen men who have had a lot of ex[-] periences along that line, and if they will tell some of them, it wi[ll] add a lot to the value of the proceedings. Mr. Reid, can I call o[n] you to open the discussion?

R. H. Reid:—We had a bridge at Franklin, Pa., consisting o[f] three 125-ft. double intersection, riveted Leighton truss span[s] which were to be replaced with six girder spans 62 ft. 6 in. long. A concrete pier was built in the center of each opening and the top[s] of the old piers were remodeled to receive the girders. When th[e] change was made the girders were run out on the bridge on car[s] and hoisted with tackle hung from the upper chords of the trusse[s] after which the cars were removed. After the rails, ties and floo[r] system of the old bridge were removed the girders were lowered t[o] their permanent position on the piers, the ties and rails replace[d] and traffic restored. These movements were all made between train[s] with no interference to traffic. The trusses were then removed wit[h] the aid of two steam wreckers, taking a hitch at each hip an[d] removing them bodily to one side where they were afterwards cu[t] up.

Owing to the increase in the weight of traffic we took down a[n] old Post truss span last year that had been built originally for [a] double track bridge across the Harlem river and remodeled it for [a] single-track span for the Valley branch. Before removing the ol[d] span from the Harlem river we built a pier beneath it, the old spa[n] and a portion of the approaches being replaced with two spans o[f] plate girders each about 100 ft. long. As the river bottom at tha[t] location was sand we had to drive a pile foundation and for lac[k] of a better method we used a steam hammer suspended by bloc[k] and tackle with guy lines to hold it in position. It was a slow jo[b] but we drove the piles without having to dismantle the truss to an[y] great extent. After the pier was built we drove the piles whic[h] were to support the truss in the same manner, dismantling th[e] truss and removing the floor system and then placing the girders an[d] putting in the new floor system.

Another case was at Petersburg, Mich., on the Monroe branch[,] where we placed a through Howe truss span with deck girders

he method was the same as at Franklin. We ran the girders out n the track on cars, raised them off the cars with tackle hitched to locking on the top chords, pulled the cars out, took out the floor, nd lowered the girders onto the piers. We had no occasion to race the bottom chord in either case. We put a little extra vertical racing in the Howe truss at the top to stiffen it against lateral ovement.

We have erected many spans of bridges over highways, where e have concrete slabs that are waterproofed and carry ballast nd ties in them. These are generally erected, concreted and waterroofed complete at one side, and the ballast, ties and rails put in ace on the structure. Then the old bridge is removed and the ew one slid into place and lowered onto the pedestals. We have oved some in that way that weighed 150 tons. We put a threean bridge in Cleveland last week, and we are putting in another day in that way, sliding them into place. We have two spans at ary, Ind., which we expect to put in place next week, over the merican Sheet & Tin Plate Company's new subway.

We have erected some girders, with the help of wrecking anes. Our derrick cars or steam wreckers will pick them up with e boom, carry them out ahead in the case of short spans, and wer them into place. In the case of long spans on double track, e run them out on one track and lower them into place on the her track.

At one point we replaced a through Pratt truss span with a rough plate girder span 85 ft. long. We took down the trusses ith ginpoles and hand work, and used a pile driver to take out the oor system of the old iron truss and put in the floor system of the rough plate girder span. Then, after the floor system was all in, e moved the two main girders to place, put them in, and connected em up on the ends of the floor beams for riveting. We had to e wreckers for that. Each girder weighed about 35 tons. We rformed all of those movements with no interference with traffic.

L. Jutton:—In the case where you replaced the Howe truss ans with deck plate girders, how did you handle the falsework for smantling the old trusses?

R. H. Reid:—We didn't put in any falsework. We carried the w girder spans on the old truss, to put them into place, and rried the old trusses on the new spans when taking them down.

J. S. Huntoon:—In the erection of most of our bridges, parularly on the main line, we have been able to get the operating

department to use a single track, and give us the other one. Th makes it very easy to erect the new girders,—put on a concrete floo if necessary, and then shift traffic over to the new bridge an wreck the other. We erected some through plate girders in Canad recently in the place of a through truss. The old truss was su ported on piles. We built concrete piers for the new girders an ran them out there, removed the falsework and jacked them dow in place, and then drove a few piles to support the truss and took down.

Where we have had the most trying cases, as Mr. Jutton spok of, is at navigable rivers. We had that in the case of the Wellan Canal over in Canada, where, even in the winter time you couldn block it for navigation. At this particular place there was a big dra bridge, I think 200 ft. long. Piles were driven at one side, the o draw bridge slid out and traffic turned over it. It was placed fa enough out that it would swing and clear the new bridge. Then th new bridge was erected across the track and swung to its ne location. Most of our draw bridges have been erected over stream that were frozen in the winter time, so we have simply driven pil and erected the new bridge in that way. I think it is largely a que tion, as Mr. Jutton said, of traffic conditions and the time one ha to work.

G. W. Andrews:—Mr. Jutton's report has, in a general way outlined very clearly the methods that could be used, have bee used, and will be used in the future, but, as he states in his conclud ing paragraph, the subject can often be treated in accordance wit the local conditions. I have been connected with the placing of great many new structures within the last 35 years. During tha time we have used many methods I think we have used practicall all the methods described by Mr. Jutton, in addition to many more In cases where it can be done economically, we have always fel that the quickest and safest way is to build the new bridge com pletely outside the old one and then slide the old bridge out an the new one in. That, as a rule, can be done in a very few minutes even with double track bridges, of which we have placed a grea many in the last few years.

During the present year, we had occasion to renew an ol Bollman truss of about 80 ft. span. I don't know whether you ar familiar with the Bollman truss or not, but it is of a rather peculia construction, first designed and built by Wendall Bollman back i the '50's. This type of bridge was built first on the Baltimore &

Ohio, and the structure I have mentioned was one of the first bridges crossing the Opequon creek, on our Shenandoah Valley Line down to Lexington, Va. We replaced a through truss with a deck girder, and we felt that it would not be economical to put in falsework on which to slide it in, or to support the track. Mr. Tanner designed and carried out a method of suspending the girders from the truss, and then taking the floor system out, which was easily done, as it was not connected by block hangers. He then pulled out the cars and dropped the floor system into the creek, after which the girders were lowered into place, ready for traffic. After completing the placing of the girders we disconnected the lateral system and the additional work put on to carry the girders, dropped the trusses into the creek and then cut them up with an acetylene torch. The material was all scrapped. This was a very quick and ingenious way, and, as it developed, a very economical one.

Another case I have in mind was carried out in the same manner while placing some 80 ft. girders on our Washington County branch, crossing Antietam creek. We assembled the girders separately at the end of the bridge, took a couple of flat cars and placed or suspended a gallows frame over the end of each car. We then ran the cars out into place and lowered the girders into position between trains. As it was on a branch line and as we made the change on Sunday we had a little more time than normally and we made a very complete and economical job of it.

J. D. Moen:—(By letter) The standardization of methods to be used in the erection of girder span bridges with the least interruption to traffic is practically impossible on account of the many features involved in such work. Each location requires special methods to suit the local conditions, except where a number of spans are to be erected under similar conditions of ground and traffic. Of the many features to be considered before deciding on the methods to be employed in erection work without interruption of traffic are the length and design of the span to be erected, whether the girders are to carry single or double track, the kind of structure it is to replace, the ground conditions at the location where the span is to be placed and the frequency of traffic to be provided for.

In many locations on all railroads girder spans are being erected to replace truss spans of various lengths and design and in many such cases deck girder spans are used. In past years

where such a change was contemplated the first feature considered by erectors was falsework which was usually placed to carry traffic during the time the change was being made and also to facilitate the dismantling of the old trusses. As traffic increased it was found that the building of falsework invariably entailed more interference with traffic, in the way of short delays to trains, than did the work of erecting the girder spans; consequently practices have changed and in many cases deck girder spans are erected to replace single track truss spans without the use of falsework, except as is required to support the old trusses while they are being dismantled. This practice is followed generally on our lines and in the past two years 13 single track truss spans of various design and of lengths ranging from 120 ft. to 250 ft. have been replaced with deck girders without the use of falsework and without interruption of traffic. The time required to make the changes and get the track ready for the passage of trains varied from 1 hr. and 40 min. for 70-ft. girder spans to 4 hr. for 100-ft. girder spans.

Where the floor beams of the spans removed are of the suspended type, deck girders are assembled and riveted complete before placing, and where the floor beams of the old bridge are supported the girders are assembled in place and riveted under traffic.

There are many locations where, on account of the density of traffic, the track cannot be abandoned for the length of time required to make changes in this manner, and in such cases it is necessary to employ other methods.

Where the floor beams of the old spans are of the supported design, girders of lengths up to 80 ft. are handled with one derrick, and the procedure is as follows:—Girders, cross frames, and lateral braces are unloaded as near the final location as possible and all cutting of old spans that can be done with safety is completed beforehand. The track is taken up and the old floor is taken out, usually in sections of three floor beams and two sets of stringers in each section, after the miscellaneous parts are removed. This makes it possible to remove the old floor with three or four moves of the derrick car. The girders are then set to place and assembled and the track made ready.

Where girder spans over 80 ft. long are being set under similar conditions, two derrick cars are used; the girders are hauled out to the final location on flat cars and are set on false

bents resting on the new piers and of sufficient height to permit taking up the old floor in the manner outlined above. After the girders are rested on the supports and fastened to the old trusses the flat cars are disposed of and the method of procedure is then the same as outlined above, except that two derrick cars are used instead of one. A crew of 18 men, including 2 foremen who are accustomed to making changes in the manner outlined, and with proper equipment, can place a girder span and make the track ready for trains in 3 hours.

Where girder spans are being erected to replace truss spans with suspended floor beams the performance is as follows: All cutting that can be done with safety is completed beforehand. The girder spans are assembled and riveted complete, loaded on two flat cars and hauled to the site. The new span is supported on bents resting on new bridge seats, these bents having both vertical and horizontal clearance sufficient to permit moving the flat cars and to be dismantled easily for quick removal after the span is lifted from them. When the new span is transferred onto the bents, dispose of the flat cars, take up the track, lower the old floor system to clear the girders, set the girders in place and restore the track. Six spans were recently set in this manner on one job on our line and the track made ready for traffic in an average time of 2 hr. and 10 min. for each span.

When through girder spans for single or double track are being erected to replace through spans of any design, it is usually found to be more expedient and economical to erect falsework where local conditions will permit. In locations such as overhead railway crossings, where falsework cannot be maintained on account of insufficient clearance, and where, on account of the frequency of traffic the track cannot be abandoned long enough to permit making changes that would take five or six hours, the method generally used, i. e., erecting the new spans on false piers or abutments and rolling them to place, as the old spans are rolled out, cannot be improved upon.

There are numerous locations on nearly every railroad where through girder spans are erected to replace timber and pile trestles in double track districts, such girders being designed to carry two tracks and at such locations both tracks cannot be abandoned long enough to permit the erection of the span in place without causing train delays. In such cases the best method is to erect the span on falsework opposite the final loca-

tion, load it on rollers and roll it to place after removing the temporary bridge. Moving heavy spans on rollers is considered much better practice then sliding them to place, as much less energy is required and there is less danger of delay through failure of some part of the rigging. If it is desired to make the change in the least possible time the falsework is also cut to clear the girders, and loaded on rollers beforehand and moved out as the new span is moved into position.

For placing spans after assembling and riveting them complete on falsework opposite the final location, we have a set of low, powerful twin roller dollies, or trucks, designed for the purpose and built at our own shops. They are capable of carrying any load required of them, with safety, and can be handled easily by one man. By the use of these dollies on rollerways of track rails, heavy spans can be rolled to place with comparatively little exertion. Changes are made and the track made ready for traffic in a shorter time by using this method of removing falsework and placing spans than in any other manner. Dollies, or trucks used for rolling spans into place are designed to carry the dead load only and provision is made for placing the span on the permanent shoes or bases immediately when it reaches its final position. This method of course may also be applied in the erection of deck girders, but it is seldom found necessary.

If traffic conditions are such that they permit the abandonment of both tracks for a period of 1 hr. and 30 min. twice each day without interference, the best method is to assemble the spans in place and do the riveting under traffic. One floor beam and two sets of stringers can be set in the time stated if proper provision is made for removing the falsework and the erection crew has plenty to do to fill in the time between shifts. This also applies to the erection of single track girder spans, whether straight or askew and whether open deck or ballast floor.

On our line we recently erected eight 100-ft. deck girder spans at one location on piers 61 ft. high. It was found that the setting of the girders temporarily on the ends of the piers outside the ends of the caps, as is often done while falsework is being removed, would entail too much cutting of falsework, therefore it was decided to remove the falsework and then carry the girders to their position and assemble them in place. A

bridge erection derrick, capable of carrying one of the girders, was included in the equipment, but on account of the track being on a new fill at the ends of the bridge, it was not considered advisable to move the girders out in this manner. Two derricks and a truck, or dummy, capable of carrying the girders were provided. One of the derricks with a boom having a horizontal reach of 50 ft. was spotted at one side of the opening after the falsework was removed. The girders were loaded, balanced centrally, on the dummy car, or truck, by the other derrick and moved out until one end extended out over the opening far enough so that it could be reached conveniently by the derrick with the 50-ft. reach. The girders were then lifted off the truck and both derrick cars moved until the girders were directly over their final position when they were lowered to place. This work was done on a branch line where traffic conditions permitted the abandonment of the track for a period of 4 hrs. each day. One span was placed each day until all were completed.

In placing either deck or through girders for single track of lengths up to 50 ft. the best method is to erect and rivet the spans complete on ways convenient to their final location, then lift out the falsework and lower the girders to place. This is done with 3 or 4 moves of a 40-ton derrick car in very short time. Much could be said on this subject in the way of performance schedules to be followed in the course of erection work, but it would be useless for the reason that each location must be handled individually to suit local conditions.

This is not intended as a treatise on the erection of bridges, nor are the methods outlined herein suggested as the best methods to be employed generally, but they are methods which have been used by the writer to suit local conditions and they are offered for the purpose of giving strength to the statement that methods cannot be standardized. The methods outlined proved entirely successful wherever used and therefore they can be considered best suited to the locations where employed.

It is a fact well established to every bridge erector that the first feature to be considered in connection with erection work is the organization. In order that such changes as are required to be made in erecting bridges under traffic, may be made successfully, and delays to traffic avoided, certain moves must be made at a specified time and every move must count. Therefore in planning such performances the organization must be consid-

ered carefully. Plans must be made for certain moves according to schedule and the schedule must be complied with. I have noted a variation of two hours in the amount of time consumed on jobs which were identical in every respect and where by actual count the number of moves made, or which should have been made, were the same. The variation in time was due to improperly organized forces. We may make plans and performance schedules to follow in erection work the same as in other lines, but it must be left to the man on the job to work according to such plans and schedules. In other words much of the responsibility for carrying out such plans and schedules rests with the "Man behind the gun."

In this day we have improved machinery and work equipment which eliminates man-labor to a large degree, but to offset this we find that it is becoming more difficult each year to get the man who will, to use a well-known phrase, "put his hands on it and do it." We have just as good men in erection work now as ever but it is often difficult to get proper team work to carry out a performance schedule. A well organized erection crew, where each man knows the limitations of his fellow worker, will accomplish twice as much on erection work as a poorly organized crew where no man trusts the other. All these matters must be given consideration when preparing a performance schedule.

Much attention must be given to the using of machinery to the greatest possible extent. Show any workman that you are trying to conserve his muscle by using machinery for all heavy work and he will usually pitch in with the right spirit and give the best he has in him in the way of efficiency. Therefore, I would say the Best Method to Use in Erecton of Girder Spans with the Least Interruption of Traffic is: Choose the method best suited to local conditions, provide adequate machinery, rigging and tools, get an organization that will use team work and then go to it.

CONCRETE CASING FOR THE PROTECTION OF STEEL STRUCTURES

By E. E. R. Tratman

Western Editor: "Engineering News-Record," Chicago, Ill.

Maintenance, repair and renewals are bogies and hobgoblins that haunt and harass the engineer and superintendent who has steel structures in his charge. Inspection and painting, reinspection and repainting, and again inspection and painting, make an unending trail that is interrupted only by the slough of occasional repairs, the rocky ridge of partial renewal, or the temporary wayside resting place of renewal or reconstruction. Wind and weather, sun, snow, rain, the dry sand of the desert, the wet muck of the swamp, the acid or briny drippings from cars, the gases and cinders from locomotives, the vibration and impact under traffic, all these and a host of other sprites and unholy influences are everlastingly at work to impair and destroy the kindly protection of the paint and to attack the timid and defenseless steel thus exposed.

As the superintendent of bridges starts to fight this host of never-resting foes with his paints and protective coatings, a detaining hand is sometimes laid upon him. He may be warned that paint costs money and must be used sparingly; let the job go till next year. Or his favorite poison is too costly, and he must get along with something that is "just as good" and costs less. When he does get into the field, other difficulties face him. It may be that his paint is being slapped upon damp and dirty surfaces. Or perhaps awkward pockets and places difficult of sight and access are being skipped, to remain as choice dens and workshops for the demon decay, the creeping corrosion or the ruthless rust.

The extensive and increasing use of concrete structures on our railways during recent years has been due in part to the fact that they involve practically no maintenance expense. With good concrete and well-made structures, maintenance, inspection and repair become merely pleasant companions for the superintendent of bridges and buildings. They take him out occasionally for a pleasant trip to convince himself of the good condition—instead of the bad condition—of his bridges and other works.

Here then we may seem to have reached unexpected goodness, finality and the smooth waters of a haven, sheltered by a concrete wall which will permanently resist the attacks of the enemy. Therefore let us build all our structures of concrete and leave them to take care of themselves while we take up other matters. But he needs a long spoon who sups with the devil, and if our destructive enemy cannot get through our invulnerable wall, he can perhaps get over or around it, and again we have to engage in battle.

We find that concrete has its limitations. The engineer plans a long-span bridge. Bang: the door is blown in and old Demon Decay is on the threshold. Concrete cannot be used. Steel is unavoidable and essential. The engineer dashes down a dark alley in search of a non-rusting, non-corrodible, absolutely everlasting and ever-resisting steel. He is still plodding after that friendly but elusive sprite.

We find that even concrete is subject to evil influences. Again, note the qualifications of concrete mentioned above: "good concrete," and "well-made structures." A mixture of cement, sand, stone and water is not always concrete. Water bewitched, cement begrudged and

aggregate inferior does not make a high-grade concrete. And if carelessness and incompetence are in charge of the work, the superintendent's troubles may begin to break out in a new direction. A crack here, a scaling there, a porous patch elsewhere, afford points of attack, and may be more obvious and unsightly defects than a worn coat of paint on a steel structure.

Well, we seem to get nowhere. Steel is troublesome. Concrete may be less troublesome, but it has its own defects and cannot always be used as a substitute. At this stage, when we may well begin to feel pessimistic, a brilliant idea strikes somebody with a flash like lightning in a powder mill. Where steel **must** be used, why not encase it in concrete instead of coating it with paint. No sooner said than done, and the engineer and bridge superintendent are now working actively along this line.

Here too are obstructions and limitations. On very long spans the added weight of the concrete becomes inadmissible. There is necessity of absolutely close adherence of the concrete to the steel. There is possibility of moisture passing through the concrete and causing corrosion of the concealed steel. There is liability of cracking under temperature and vibration movements of the steel. Nevertheless this is a promising field, which widens as we go farther into it.

The practice of applying a concrete casing to girders, viaducts and other steel structures has been adopted on a considerable scale, and is on the increase. It is employed for three reasons, more or less in combination: First, to protect the steel against atmospheric destructive influences; Second, to protect it against the destructive effects of the hot gases and cinder blast from locomotives; and Third, to improve the appearance of the structure.

The casing may be of three kinds. In the first place it may be of ordinary concrete placed in forms as in usual practice. In the second place it may be concrete mixed under steam pressure with about 50 per cent. superheat, and then blown into place through a small pipe by steam pressure. In the third place it may be a cement-sand mixture known as gunite which is blown upon the steel through a hose by compressed-air. Density is a special feature of concrete or gunite applied by pressure, and the steam-placed concrete is said to weigh about 170 lb. per cubic foot, as compared with 135 lb. for concrete made and poured in the usual way. And density is specially desirable in work of this kind.

Steel reinforcement is required in any case, with special attachments to bond the concrete to the steel. Longitudinal rods are generally used with wire mesh over flat surfaces and projecting flanges, and around small members. Sometimes cross rods or anchors are put through the girder webs. According to a report from the Kansas City Terminal Railway, in the 1916 "Proceedings" of the Association, the cost per square foot is about 25 cents for concrete placed in forms, and 23 cents for "gunite" placed by compressed air and the cement gun. These prices include concrete, reinforcement and labor.

When ordinary concrete is used a relatively thick mass must be applied. There is doubt sometimes as to the close adhesion of the concrete to the steel, and as to the protection against moisture which may be absorbed by the concrete and thus come into contact with the steel. On the other hand, this method permits the formation of panels, molding, etc., to relieve the surface and give an effect of architectural treatment. A rich mix with small-size coarse aggregate is required, the mix being very generally 1: 2: 4.

The gunite, applied by compressed air, differs from ordinary concrete in having no coarse aggregate, as the material has to be applied with a hose. It is usually about a 1: 3 mix. This material has the special advantages of high density, with small absorption of moisture, and close adhesion to the steel.

Concrete casing of steel bridge work has been employed in several

cases on track elevation work in Chicago. A prominent example is the skew bridge carrying the Rock Island tracks across the Chicago & Western Indiana, at 79th St. There are five through plate-girder spans of 85 to 90 ft., with plate girder floor-beams resting in the bottom chord, and having their tops enclosed in the reinforced concrete deck slab. Beneath the deck is a 5-in. slab at the level of the chords of the girders, protecting the steel from the blast of locomotives passing under the bridge. Steel bars are run through holes in the stiffeners, and wire mesh is laid over the chords, webs, gussets to floor beams, etc. The concrete coating was applied by the cement gun. It is 1¾ in. thick on the girder webs, gussets and other flat surfaces, 2 in. under the floor beams, and 3 in. on the chords of the girders.

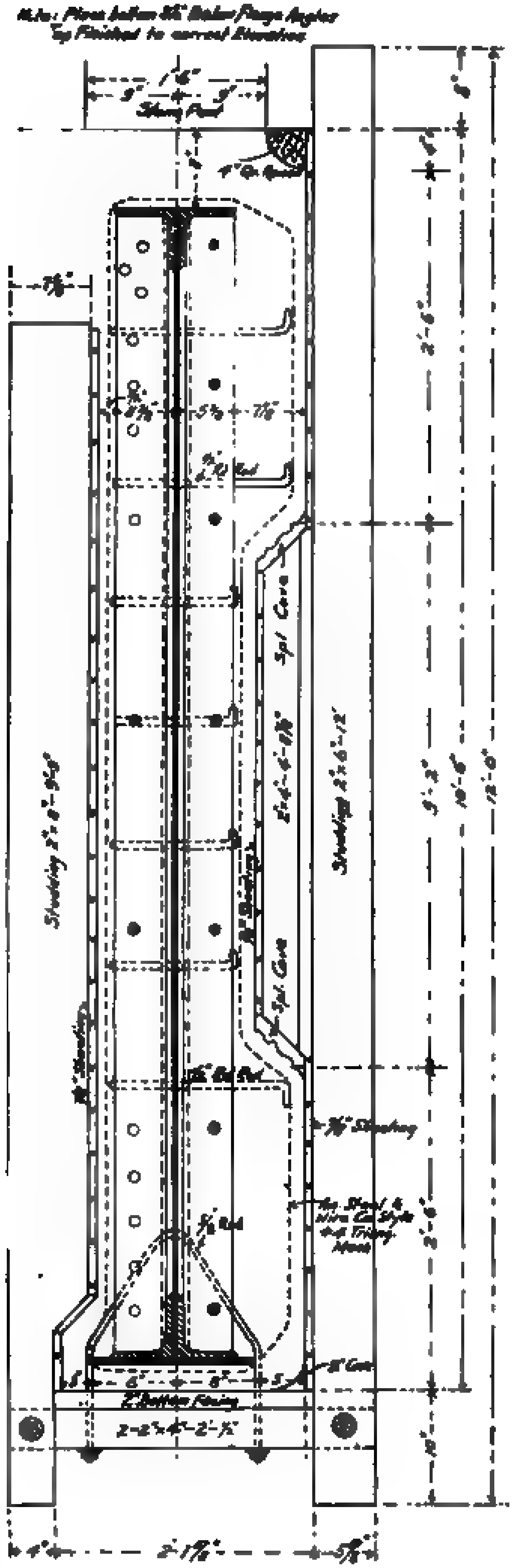
Poured concrete was used for the bridges on the track elevation of the New York, Chicago and St. Louis from 73rd St. to 79th St., Chicago. The 75th St. bridge is a typical example. This has two 25-ft. roadway spans and two 10½-ft. sidewalk spans, with through plate girders and a floor of transverse I-beams embedded in a concrete slab with reinforcing of steel rods and wire mesh. Each post of the bents is composed of two channels and an I-beam, and the posts are connected by diagonal braces of four angles with web lacing. The casing of girders and decks forms one solid mass. That of the bents gives finished rectangular sections. The concrete is a 1: 2: 4 mix, using 1-in. stone, and is at least 1½ in. thick over all steel. The estimated cost of the concrete casing is as follows (1912 prices):

Concrete, 180 cu. yd. @ $10.00,	$1,800
Wire mesh, No. 23, 2550 sq. ft. @ $1.98 per 100,	51
Wire mesh, No. 74, 4850 sq. ft. @ $0.58 per 100,	28
Wire, No. 14, 63 lb. @ $1.35 per 100,	1
Rods, 2370 lb. @ .025 per lb.	59
	$1,939
Allowance 15%,	291
Total,	$2,230

On the long-span girder bridge carrying this line over the Illinois Central the concrete floor is shaped to form jack arches between the webs of I-beams, the lower flanges being heavily encased. The columns and the transverse trusses between them are cased in concrete but the girders are not so cased above the floor level.

At Layfayette, Ind., the Main St. bridge over the river is a steel plate-girder structure, having six spans of 126 ft., with the outer girders cased in concrete. This was done mainly for the sake of the appearance. The bridge was built in 1913-14. Owing to the fact that the concrete was placed during extremely bad and some very cold weather, the appearance was not as good as desired. The principal trouble was in placing the concrete. The forms were not sufficiently rigid to carry the whole mass at one pouring, so that it was necessary to let the concrete set when about half of it was poured. The result was a seam that is noticeable in the work. The concrete was bush-hammered with pneumatic tools after it had darkened. The general appearance is good with the exception of the mark above referred to. There has been no cracking of any kind in the surface up to this time, nor separation of concrete from the steel. The concrete was a 1:2:4 mix.

Cross-rods are put through the girder webs, averaging one per square foot of surface. These are ½-in. rods, with threads cut half way, and nuts screwed up against each side of the web to hold the rods in position. The unthreaded end of the rod was bent sharply at a right angle. These rods were of such length as to reach within 2 in. of the surface of the concrete. Longitudinal rods were passed through holes in



Cross Section of Concrete Casing for Girders of Main Street Bridge, Lafayette, Ind.

the stiffeners, and a sheet of wire-mesh extended around the girder and the edges of the cross rods.

The forms were held by inverted U-bolts, having the upper portion of V-shape passed through the girder web. The lower vertical portions of the legs passed through cross timbers supporting the forms. In this bridge the spans were too long for concrete girders, and arches would not have given the desired clear waterway for flood flow.

A very exceptional and interesting example of the use of concrete casing is the viaduct approach of the St. Charles Bridge of the Wabash Railroad over the Missouri River. This old viaduct or trestle, with Phœnix columns, built in 1884, was designed for Cooper's E-25 loading. About 1900 its strength was increased by filling the columns with concrete. In 1910 it was strengthened for E-50 loading by converting it into a reinforced-concrete trestle. For this the old columns and struts (all Phœnix sections) were encased with concrete in which the necessary reinforcing rods were embedded, together with a spiral steel wrapping. As an experiment one four-post tower was treated in this way in 1908, in order to see how the concrete would stand exposure and vibration. The results being successful the complete work was carried out in 1910. Laboratory tests of sample columns indicated that the strength had been nearly doubled.

The shoes are enclosed in concrete blocks. The concrete columns are of octagonal section and the struts are of rectangular section, with gusset connections to the columns. These gussets enclose the ends of the diagonal rods, the rods being left in place although they are not needed in the reinforced concrete structure. After the base or shoe blocks had set, the steel rods and wrappings were placed and the forms set in position. The concrete was a 1:3 mix of cement and sand. The column casing averaged 0.0590 cu. yd. per lin. ft., while the interior filling averaged 0.0074 cu. yd., making a total of 0.0664 cu. yd. per lin. ft. of column.

The concrete was poured from a work train on the structure, equipped with mixer and material cars. The work is described fully in Engineering News of Nov. 10, 1910. It was done by the W. P. Carmichael Co. on a force-account system, as cost estimates of such work could not well be made. The design and execution were under the direction of Mr. A. O. Cunningham, Chief Engineer of the Wabash R. R.

There seem to be possibilities of the application of this treatment to water towers, coaling stations and other structures.

An instance of the use of concrete casing for the sake of appearance is the track-elevation viaduct of the Baltimore & Ohio across Independence boulevard, Chicago. It is a four-track plate girder structure 250 ft. long, with two 35-ft. spans over the driveways. These are made distinctive by heavy piers and by decorative treatment of the piers and the girder casing. This was poured work, using a 1:2 mix of cement and crushed limestone, without sand. The aggregate ranged from dust to ½-in. size.

A more elaborate example of the combined protective and decorative use of concrete casing is a portion of the Boston Elevated Railway, at Forest Hills, Mass. The four-post steel towers are encased to represent masonry piers. The outer girders have curved brackets supporting a curved mask of concrete which extends from the bottom chord of the girder to the edge of the deck, where it is surmounted by a concrete parapet wall. The girders are then well covered with concrete. The top chords are embedded in the concrete deck slab and the bottom chords in a light slab which serves to conceal them from below. This is all poured concrete, a 1:2:4 mix, using ½-in. stone. This work was reported in 1917 as being entirely successful and satisfactory. In some places on the water-table the concrete had cracked away from the reinforcement, but this was through no fault of the concrete work. The color has darkened somewhat since the concrete was new. Somewhat

similar treatment has been applied to the station and structure of th New York Elevated at Pelham Parkway. This was a 1:2:4 mix, mad with ¾-inch stone, and spouted to the forms from an elevator towe A bush-hammered finish was given and some inlaid tile decoration wa included. As described in "Engineering News" of January 4, 191 this cost $12 per cu. yd. of concrete.

In the track elevation of the Boston & Maine at Lynn, Mass., co crete masking of the girders was required by the legislative act relati to the work. This is not a protective casing, however, the concrete b ing applied only on the outside of each outer girder. This also wa form work. Its cost was $4.25 per sq. yd., in 1914-15. Much of th masking was done during the winter, steam coils and straw packin being used to heat the forms and prevent the concrete from freezin A recent example of poured concrete casing is the three-span throug plate-girder bridge carrying Cambria St. over the Philadelphia & Rea ing at Philadelphia. The concrete was used largely as a protectio against corrosion. It is a 1:1½:3 mix, anchored to the girder webs b 1¼-in. bars spaced about 12-in. centers. The surface was bush-ham mered, or lightly chiseled by hand at places where use of the hamm might cause spalling. The cost of this concrete was about $10 per c yd. ("Engineering News-Record," April 5, 1917.)

Reference may be made to the Wabash bridge over the main e trance to Forest Park at St. Louis, as this is sometimes incorrectly me tioned as an example of concrete-encased steel structures. This is through plate-girder bridge of 80 ft. span with exterior concrete facin The steel is not cased in concrete, however, and the latter serves mere to conceal the girders and give an attractive appearance to this bridg over a pleasure driveway The concrete facia girder and railing a 3 ft. from the steel girder, and are built upon angle iron frames attache to the web and bottom chord of the girder. The frames are about ha the height of the girder and carry a wooden covering between the ste and concrete, thus forming a tar-and-gravel gutter. The concrete gird was built in a wooden form attached to these girders, but the ornament railing which surmounts it is composed of pre-cast balusters and co ings. This work was done in 1903 and has proved very successful.

In all decorative work, care must be taken to prevent surfa cracks or crazing, and patchiness of color. In the Baltimore & Oh work at Chicago noted above, special care was taken to have all co crete of uniform proportions and consistency, so as to maintain uniform ity of color. After the forms had been removed and the concrete se soned for a few days, all ridges were chipped or filed off. The surfa was then wetted and rubbed with carborundum brick, and then a th wash of cement and sand was applied. When this was dry a rubbing w given with a finer carborundum brick, until the cement wash was a removed.

Reviewing the situation, what does experience teach us and wh relief is promised to the engineer and the superintendent of bridge In the first place, concrete casing promises certain advantages in r ducing the amount and cost of inspection and maintenance of ste structures. As an example of this, one road reports that repainting ste bridges averages 60 cents per ton per year, while for concrete casin done a few years ago there has been no maintenance cost as yet, and n cracks or defects have appeared. Concrete also has an advantage as mechanical protection, affording additional resistance to the attacks gases, acids and cinder blast.

Two points are essential for permanent success: The concre must have close adhesion to the steel, so that moisture cannot get b tween the steel and concrete, and the concrete must be dense, so th moisture cannot work through the concrete to the steel. Rememb that the steel cannot be painted if it is to be cased with concrete, that will impair the adhesion. Therefore, if Old Man Moisture can g

through or around the concrete he finds his prey, the steel, bare and exposed to attack.

In listening to this paper you have heard of several unfriendly and insidious influences; Demon Decay, Creeping Corrosion, Ruthless Rust, and Old Man Moisture. You may wonder why no Good Fairy of Permanent Protection is mentioned. The reason is that no such ally has yet been found. We have found some ways of circumventing the numerous enemies. But the battle continues. Therefore, "Carefulness, Watchfulness and Persistence" must be the slogan of the Railway Superintendent of Bridges and Buildings.

DISCUSSION

The President:—I think the association owes a debt of thanks to Mr. Tratman for having presented such an interesting paper, written in such an impersonal way. It would be interesting at any time and is especially so now, as it tells very completely what has been done along these lines. I don't know whether any members have anything to add or not. If so, we will hear from them now.

L. D. Hadwen:—We have employed concrete protection around steel on girders, and we have also applied gunite in some instances to protect the under sides of viaducts where they were exposed to locomotive exhausts. While these methods have not been in service long enough for us to determine definitely, so far no defects have showed up. One essential in the covering of steel with gunite is to get the steel absolutely clean. One must sandpaper the steel in order to get good results.

We find the trouble with applying gunite for the protection of the under sides of the viaducts exposed to the locomotive blasts is that it has been a matter of very great expense to take care of our staging, etc. The places that are most exposed to deterioration from constant traffic underneath the bridge are those where you have the densest traffic. Usually that adds a problem to any gunite work done and makes it very expensive. Of course, in painting you do not need the head room that you do with gunite, for with it you have to have some staging, so the men can work underneath.

C. W. Wright:—On the steel in the terminal of the New York Central at New York they used a cement gun, but they used reinforcing of galvanized wire, probably a No. 7, laced with a lighter wire. I don't know about the results, but I haven't heard anything unsatisfactory lately. If there had been anything unsatisfactory, I believe I would have heard of it.

The President:—I will say from the information I ha had on the subject, that all thin coatings will ultimately requ some reinforcing to make them successful, whether the concre be placed as gunite, by compressed air, or placed in forms, a also, that a heavier reinforcement will be necessary. There a many places where cement coverings have been placed on st in the past, and a very light reinforcement has been put up, p sumably on the idea that it was only necessary to hold the co crete there long enough for the concrete to adhere to the ste Where that has been done, the corrosive elements have eat out the thin reinforcement, and I think the coating will not successful unless there be formed a skeleton of rods, to hold t coating in place after the finer material corrodes, if it does co rode, and then a finer mesh, to hold it while it is being placed.

B. F. Pickering:—I would like to ask if it is necessary apply heavy reinforcement on account of the lighter reinforc ment rusting away from the moisture? Isn't it also reaso able to suppose that the steel girder that is encased is sufferi the same way? In the paper read by Mr. Tratman he spoke the steel viaduct in the city of Lynn. I want to speak furth on that same viaduct. He evidently speaks only of the viadu across Central Square West. There is another portion of th which is of steel, and is also encased in concrete. The prote tive coating over it was not sufficient to keep the water o and I find that it runs down between the cement coating and t steel beam. It is a very grave question with me how long th steel is going to stand that action without deteriorating such an extent that it will become dangerous, with no chan to inspect the steel. It looks to me that unless the water kept out between the steel and the concrete, the concrete w become a menace, rather than a help, in the preservation of t steel.

The President:—I think there is no question in a case that kind but that the concrete covering should be cut out, b cause if the water gets to the steel and continues to run, there no question but that the steel is going in time. The corrosi elements that I referred to are those that come from absorpti from the outer surface of the concrete and will soak in f enough to get to the steel. Of course, with the heavier rods, t chances of the corrosive elements getting through the concre far enough to get to the plate steel are very slim, but in t

other case that was mentioned, the only safe thing is to find out immediately where the water is getting in, and stop it.

G. M. Hoffman:—We have two subway bridges with steel ceilings on the Shamokin division, and they are constantly leaking and rusting the rivet heads and different parts of the ceiling. One bridge has been built four years and the other three years. I painted both of them this summer, when I discovered that quite a lot of rivet heads had been rusting, and that there was a continual dropping of water. The bridges were not completed a year before they started to leak. There must be water in back of the steel ceiling for it keeps dropping through. Should openings not be made so the water could get out?

The President:—What you need is an efficiency system of water-proofing which will shed the water and keep it from getting in. Any complete system of water-proofing will stop the water and throw it off. I know that when I was on the Lake Shore about 15 years ago, we had a number of bridges where the steel floor was rusting out. An efficient system of water-proofing was put in and the steel didn't corrode any more.

REPAIRING AND STRENGTHENING OLD MASONRY

REPORT OF COMMITTEE

Soon after the appointment of the Committee on the above subject, of which A. I. Gauthier was chairman, a circular letter was sent out requesting suggestions in connection with the preparation of a series of questions to be submitted to the various railroads in the hope of securing reliable data on the above subject. A consideration of the replies received by the chairman resulted in the preparation of the following set of questions:

Abutments and Piers

1. Assuming loads are not to be increased, when do you consider it advantageous and effective to:

(a) Pin and point joints in the face of old stone masonry originally laid dry where walls are not to be grouted at the same time?

(b) Grout masonry originally laid dry?

2. Assuming loads are to be increased, when would you consider it advantageous and effective to grout masonry originally laid dry?

3. Give a detailed description of the apparatus and methods used (with sketches and photographs if possible) on any important work where grouting of the old masonry laid dry has been resorted to and the success which has been obtained.

4. Give a description of the methods used and the results obtained in strengthening masonry that shows signs of failure owing to:

(a) Insufficient sections.

(b) Yielding foundations.

When conditions are such that:

(a^1) No additional work will be permitted in front of the existing masonry.

(b^1) When there is ample room for buttresses, etc.

5. When abutments are partially undermined, give a description of the methods used to repair them.

6. When conditions referred to in questions 4 and 5 arise, give the methods used to maintain traffic while repairs are under way.

7. What experience have you had and what success have you obtained in tying together defective parallel wings of bridge abutments with iron rods?

8. Give a description of the methods used to strengthen old masonry of all classes to carry heavier loads.

(a) To distribute the load from the superstructure.

(b) To reinforce foundations.

9. Give a detailed description accompanied by plans, sketches and photographs where possible, of any important work involving conditions noted in questions 4, 5, 6, or 7, stating whether the work was done by contract or by company forces, with cost data if available.

Arches

1. Give a statement of the methods used in repairing stone arches. If you have had any specific cases, state the condition of the structure before repairs were made, and how the work was handled, giving plans, sketches or photographs where possible and cost data where available.

2. What success has been obtained in tying together the spandrel walls of arches with iron rods?

Retaining Walls

1. Give a statement in regard to the methods used in repairing d fective retaining walls, if any experience has been had along these lin

Before the above list of questions was sent out to the various ra roads, Mr. Gauthier entered the service of his country in France, th leaving the committee without a chairman. Early in August, the pr ent incumbent was requested to act as chairman with the hope that would be able to get out a report in the absence of the regular chairm

To date, replies have been received from E. G. Lane, of the Bal more & Ohio Western Lines; B. F. Pickering, of the Boston & Mai George E Boyd, of the Delaware, Lackawanna & Western; John Bohland, of the Great Northern; E. M McCabe, of the Boston & Alba Moses Burpee, of the Bangor & Aroostook; S. C. Bowers, of the Pe sylvania Lines, West; Lee Jutton, of the Chicago & North Weste and F. E. Schall, of the Lehigh Valley.

Upon considering the data so far received, it was decided to gro the replies from the railroads in the same order as the questions sent o

Abutments and Piers

1. (a) The Boston & Maine, as a rule, does not consider it necess to pin and point joints in old stone masonry originally laid dry, unl some special case required it. In that section, there are very ma pieces of old masonry which were laid dry many years ago and wh are of rough stone, that, in many cases, is rough and open. In such ca the labor of pointing is thrown away, unless a more sightly job is quired.

The Boston & Albany is of the opinion that with old masonry l dry, if the foundation is in good condition, pinning and pointing sho be done as quickly as possible to prevent the stone from worki Should there be any movement in the masonry, joints would show up

The Chicago & North Western suggests that joints in old stone m sonry, laid in mortar, should be pointed when the mortar has fallen for a depth of ½ in. in most of the joints. If this is a small job, it be deferred until other work of the same nature develops in the vicini

The Lehigh Valley thinks there is little reason, except possibly looks, for pointing stone masonry laid up dry, when the walls are failing, and are not to be grouted at the same time.

The Bangor & Aroostook does not recommend the pointing of masonry originally laid dry unless grouting at the same time is conte plated.

1. (b) The Lehigh Valley advises that the grouting of dry mason will greatly prolong the life of the wall if properly done, and recommen closing and pointing the joints for a height of several feet at a tim starting at the foot of the wall, and providing small openings in the wa at intervals, for pouring in the grout, continuing this process until t top of the wall is reached.

The Chicago & North Western does not believe that a good mason wall can be made by grouting old dry masonry.

The Boston & Albany recommends the prompt grouting of dry wal especially if there are small and ill-fitting stones in it with a view to pr venting movement in the masonry.

The Boston & Maine recommends grouting in a thorough mann as soon as the walls show signs of the stone working loose.

2. The Lehigh Valley recommends that walls be pointed and grout before being subjected to heavier loads, to prevent distortion and shi ing of the stones

The Boston & Albany recommends that where old masonry has be laid up dry for any length of time, the walls should be pointed a grouted so as to fill all voids and stop any movement liable to take pla

in the old masonry, but if the stone has not been cut, it does not pay to spend much money on masonry laid dry. The experience of this company is that old masonry usually gives plenty of warning, in which case a reinforced concrete bridge seat proves effective. Concrete bridge seats on cut stone masonry laid dry, have been holding up well under increased power, where the foundations were in good condition. This Company does not, however, recommend pointing or grouting if the old foundations are poor and show signs of settling under the old masonry.

The Boston & Maine advises that where the original walls are of sufficient area to carry increased loads and the foundations are in good condition, grouting may be resorted to with economy and usually with satisfaction.

3. The Lehigh Valley advises that the face joints should be thoroughly wedged and packed and then pointed for a height of 3 or 4 feet from the bottom. At that point, small stones should be removed at intervals of every 5 or 6 ft. The grout should be poured into the wall by the use of a pan-shaped, sheet-iron spout, that can be inserted into the wall for a short distance, the grout to be poured until it reaches the height of the pointing. The temporary opening should then be closed and another section of three or four feet in height should be pointed in the same manner as above described, this method to be continued until the top of the wall is reached. The grout should not be expected to run any great distance, and the party in charge of the work should be guided by the condition of the work before him.

The Boston & Maine recommends that the joints of walls to be grouted, should be thoroughly cleaned of all debris and carefully pointed, and that the grout should be placed as far back from the face as possible, using a wet mixture that would run into voids otherwise inaccessible. Results in this class of work have been uniformly good.

4. (a) The Lehigh Valley advises that buttresses or a complete facing of the wall with concrete may be resorted to as the case in hand may require, always anchoring the new wall to the old.

The Chicago & North Western recommends the placing of a jacket of concrete on the old masonry, bonded to it by means of rods or dowels.

The Boston & Albany recommends encasing with concrete, removing a course or two of stone from under the bridge seat and then grouting and replacing the bridge seat with concrete reinforced with old rails.

The Boston & Maine advises that it has had little experience in this class of work, but now has several cases that need attention.

4. (b) The Lehigh Valley recommends, for yielding foundations, the underpinning of the old structure by placing toe walls under the front of the wall. These walls must be placed in sections about 6 ft. in length to avoid further weakening of the structure. To be effective, these toe walls should extend under the old foundations not less than 18 in.

The Chicago & North Western suggests that for ordinary piers and abutments, the most feasible way is to take down the old masonry, construct new foundations and relay the superstructure. In the case of large piers and abutments, a special program should be worked out for repairing the foundation.

The Boston & Albany advises that when necessary to repair structures on account of yielding foundations, excavations are made to good material and the material replaced with concrete reinforced with rails or rods.

The Boston & Maine recommends the use of buttresses when there is sufficient room for their construction, the foundations for buttresses to be obtained by excavating to satisfactory material or providing piles for them. It also recommends the removal of sufficient stone from the old masonry to make a satisfactory bond with the concrete. If the old

structure is too weak to carry traffic while repairs are being made, fa work should be installed.

The Great Northern cites an instance of partial failure of the wi walls of a bridge near Dryden, Washington. This structure consisted high abutments carrying two deck truss spans. The trouble was re edied by constructing pile trestles back of the abutments and removi a portion of the filling. The pile trestles were later replaced by t 16-ft. concrete slab spans on the west end and by one 32-ft. girder a one 16-ft. concrete slab span at the east end. No further movement the wing walls has been observed since the filling has been removed a the bridge extended as indicated above. A number of other cases si ilar to the above, were treated along the same lines.

4. (a¹) The Lehigh Valley recommends that when no buttresses c be placed in front of the wall, it may be necessary to place reinforc ments in the back of the wall, which may be done by means of b tresses or additional masonry anchored to the old wall in such a w as to draw the center of gravity away from the front.

The Boston & Albany reports that when conditions exist which w not permit the use of buttresses or the encasing of the old masonry the front, it has been found practical to remove the old masonry and build the structure with concrete.

4. (b¹) The Lehigh Valley reports that when there is ample room front of the wall, buttresses or a complete facing of the existing m sonry may be necessary. But in most cases toe walls are required addition to buttresses or facing walls, since the trouble in walls faili usually comes from the toe pressures on the underlying soil being t great for such soils to carry.

The Boston & Albany advises that instead of using buttresses, a c ing of concrete of the necessary thickness is used. This latter depen on the condition of the abutment and the height. The facing of the co crete is reinforced with rods, spaced three ft. apart perpendicularly.

5. The Lehigh Valley reports that repairs to partially undermin abutments are usually made by underpinning with concrete, carrying toe wall along the damaged part and facing the wall for a short d tance up. When water is encountered, sheet piling and shoring are quired, and the repairs should be made in short sections, so as not damage the old wall further. Special care must be taken in sandy s foundations, not to disturb the support under the wall by pumping.

The Chicago & North Western advises that when abutments a partially undermined, such as would be caused by a washout, tra should be carried on false work, and repairs to the foundation should made by putting a proper cofferdam in and then placing the concrete

The Boston & Albany recommends underpinning with reinforc concrete, exercising proper care where work is done under traffic so not to undermine the abutment and cause the loosening of stone in t structure.

The Boston & Maine reports an interesting case which occurr over a year ago, when, by the breaking of a dam, both abutments o bridge over a small stream were undermined in some places to a dep of 4 ft., and in no place less than 2 ft. below the footing course. Th abutments were supported by pile foundations. This pile foundati did not fail and the abutment did not settle to any extent. The pro lem which presented itself was how to refill under them, as the water the river would not go down for several weeks. Sixty-eight carloa of rubble stone of various sizes and some crushed stone were placed the front of these abutments. This filling was carried somewhat abo the footing course. False work was then installed in the back of t abutment to carry traffic, and the material was removed to the botto of the abutment. Steam pumps were installed on the bank of the strea having a nozzle pressure of 200 lbs. A ¾-in. nozzle was made fro

pipe, especially for this case, and about 30 carloads of sand were blown underneath each abutment until absolute refusal. These abutments have remained absolutely solid, are carrying their heaviest power over them, and show no signs of settlement.

The Great Northern cites a case of this kind in connection with a bridge near Corson, South Dakota. The bed of the river at this bridge was badly washed by a flood in June, 1914, the center pier being undermined so that it was necessary to take it down and rebuild it, carrying the footing to a greater depth. The west abutment was undermined at the toe, but did not move. This abutment was saved by underpinning at the toe with a block of concrete. This concrete was put in in short sections, so as not to disturb the footing any more than necessary. This work was carried out successfully, and no further trouble was experienced.

Near Ferndale, Washington, it was necessary to remodel the center pier of a bridge. This bridge contained a light steel draw span which had to be replaced with a heavier structure. This required a larger center pier. The work was accomplished by building a concrete jacket around the old pier.

6. The Lehigh Valley advises that when the strengthening of abutments is done, such work, if properly done in short sections, can usually be accomplished without supporting the superstructure carried by the masonry, but in very soft bottoms or in fine sandy soil, it may be necessary to place supports under the superstructure. When the strengthening is done in the rear of the abutment, it is necessary to drive piles and place temporary bents and stringers to carry traffic while excavating the embankment back of the abutment. The one case in which this method was employed, has given no trouble since the strengthening was done.

The Chicago & North Western reports that when repairs to piers and abutments are being made, it is almost always necessary to put in temporary false work.

The Boston & Albany maintains traffic by providing two four-pile bents as close to the back of the abutment as conditions will allow. These bents are driven as close to each other as possible, so that in case there are any broken piles in the first bent, the second bent will take care of them and another bent can be driven 12 ft. back of the double bent. If the abutment is to be removed, additional bents may be necessary. It has been found practical to use 20 to 24-in. "I"-beams temporarily, to carry the track on these pike bents, two "I"-beams being bolted together with separators under each rail. In front of the abutment 12 in. by 12 in. timber bents are used. The general practice is to use double bents with two batter posts and four plumb posts, double braced with 3 in. by 10 in. timbers. "I"-beams have been found more convenient to place under the tracks than timber, as they take up less room.

The Bangor & Aroostook maintains traffic by the use of pile bents where repairs to abutments are being made.

7. (No data.)

8. (a) The Lehigh Valley distributes the increased load of the superstructure on masonry. A good method, when possible, is to encase the existing masonry near the bearings, take out the bridge seats and enlarge them to reach over the encasement. This method also increases the bearing area of the soil. Where additional bearing is required on the top of the masonry only, this can usually be accomplished by taking off the coping stones under the bearing and placing a steel grillage or steel casting of sufficient size under the bridge to distribute the load.

The Boston & Albany has either encased the old masonry with concrete, or replaced it with the same construction to take care of heavier traffic.

The Delaware, Lackawanna & Western has, in most instances, fou
it desirable to take down all work to the footing, increase the size
the footing and rebuild the superstructure to the bridge seat. In o
case recently, where it was necessary to raise the track on account of
grade crossing elimination scheme, it was found that the abutments d
not have sufficient bearing and they were strengthened by reinforci
the toe.

8. (b) The Boston & Albany states that if the foundations are so
piles are driven for the whole abutment, if the old masonry is to be r
moved.

9. The Boston & Maine states that this question covers some i
portant work in tidal streams done by them. The rise and fall of ti
is about 11 ft., the current approximately 14 miles per hour. Two pie
14 ft. by 60 ft., carrying 200-ft. truss spans, were built originally
placing a crib around a cluster of piles driven to a solid foundation a
then filled with small stones. Then the entire section around the pie
was grouted by dumping very heavy stone as well as smaller mater
to a depth of approximately 6 ft., leaving the water at low tide appro
imately 8 ft. deep. On top of this crib was built granite masonry. Abo
two years ago it was found that worms had eaten the crib and the e
cased piling to such an extent that the masonry had settled a
cracked.

Cofferdams were installed, which served as forms around each
the piers about 4½ ft. out from the piers at the bottom and running
ft. from the pier 2 ft. above the high water line. All surfaces we
cleaned as thoroughly as possible by a diver, then concrete was plac
until well above the old crib leaving pockets and chutes into the cr
at intervals for the grouting of the old crib. This was done with a mi
ture of one part Portland cement and two parts sand. Approximate
140 bbls. of Portland cement were used in this grouting on each pi
then the concrete was built up to 2 ft. above high water and the for
were allowed to remain on the first pier through the winter season. B
after taking these off, it was found that the concrete in the abutment w
wasting away near the low water line, although this did not occur un
after the forms were taken off. To offset this on the second piers, 4-i
hard pine plank casing was installed on the inside form with 1 in. by
in. lag screws screwed into the inner surface and allowed to proje
back into the concrete about 9 in. with pressed washers underhea
When this was completed, the forms were removed after suitable setti
of the concrete. They have had no difficulty with the wasting of co
crete on this pier, the casing extending below low water and to the hi
water line. Measurements have been taken from time to time, but no se
tlement has been discovered in these piers since this work was done. A
of this work was done by company forces and cost, including all form
diver, etc., about $8 per cu. yd.

The Baltimore & Ohio Western lines have done considerable repai
ing and strengthening of old masonry, but in many instances it has n
been satisfactory. The old masonry in this territory was constructe
mainly of very soft sandstone or limestone slabs. As reinforceme
has not been very satisfactory, about 98 per cent of the masonry whic
has to be repaired or strengthened, is now being taken down and r
built.

Arches

The Delaware, Lackawanna & Western reports the failure of a num
ber of arches during the past four or five years. These arches were bui
in the early eighties, and, in the main, are still unusually fine specime
of cut stone work. In some cases, failure has been due to lack of prope
drainage and the action of frost. In most cases, however, there wa
very apparent evidence of overloading of the arch due to increase

weight of equipment. Where failure was caused by defective drainage and frost, it was not found feasible to drain the structures effectively, although conditions have been greatly improved by cutting holes in the masonry. Whether the failure was due to lack of drainage and frost or to overloading is not known, but all structures were lined with concrete of varying thicknesses, depending on conditions surrounding each job, and so far this method has proved very satisfactory.

The Pennsylvania Lines west of Pittsburgh report that extensive repairs have been made to arch bridges on the Pittsburgh division, some of which were built as early as 1852. On some of these arches, as originally built, the parapet walls were given 6 in. projections for a depth of three courses to provide sufficient width for the track. The action of frost and ice pushed these walls out, making the structures unsafe for heavy equipment. A number of these structures were strengthened by encasing the old bridges completely in concrete, carrying foundations to rock and adding wing walls where T walls were built originally. These bridges are standing up under increased traffic, giving the best of service, and so far, none show any defects. It is therefore felt that this is a most satisfactory method of prolonging the life of arches where the waterway is sufficient to allow encasing them. The cost of concrete work of this character, exclusive of reinforcing material, is about $12 per cu. yd.

The Great Northern reports the strengthening of its stone arch bridge over the Mississippi river at Minneapolis, Minnesota. The structure consists of a series of 80 ft. semi-circular arches, and was built in 1883. Considerable care was exercised in its construction, with a view to getting a permanent structure. It is located just below the Falls of St. Anthony, where the line passes through the main milling district of the city. Several serious longitudinal cracks developed in the arches from time to time, which made it necessary to give this structure careful study, with a view to determining the cause, and devising some plan to overcome the trouble. The conclusion was finally reached that the failure was due to insufficient drainage which permitted the rock filling to become filled with water, and that the cracks were the result of water freezing and spreading the spandrel walls. Openings for drainage were provided through the parapet walls. Tie rods were provided extending entirely through the structure together with anchor rods extending into the structure a distance of 10 ft. The rock filling above referred to, was removed and the space filled with concrete. No further defects have developed since this work was done.

The Lehigh Valley reports a few cases of defective stone arches, in which the form of the arch was considerably distorted and the ring cracked. These arches were repaired by constructing new foundations, side walls and arches inside of the defective structures. While the placing of the arch ring lining is a tedious job, it can be done successfully if a comparatively dry mixture is used, so that it can be packed thoroughly in place. The sections for the lining of the arch necessarily have to be short, so as to be reached from the ends of each section to be able to compact the concrete properly. The work that has been done has proved satisfactory. While no costs are available, the work is expensive on account of having to provide centering, sheeting, etc., the same as for a new arch.

The Chicago & North Western reports that where parapets and wing walls of old arches have become disintegrated, repairs have been made by removing the upper courses and replacing them with concrete. In making repairs in this manner, the concrete was bonded to the old masonry by rods.

The Boston & Albany has furnished the following detailed cost data covering the replacing of a stone arch with concrete:

Unit Cost: Driving piles (598 ft.)

Labor, etc.		$0.284	
Material (598 ft)		0.0987	per f
Total,		$0.3827	per f
Stone masonry removed (77 cu. yd.),		$2.968	per cu. y
Wet excavation (50 cu. yd.),		$2.151	per cu. y
Earth excavation (108 cu. yd),		$1.298	per cu. y
Concrete (124 cu. yd.)			
Material,	$ 441.15	$3.557	per cu. y
Labor,	850.79	$6.861	per cu. y
Total,	$1,291.94	$10.418	per cu. y
Cofferdam (75 lin. ft.)			
Labor, etc ,		$4.48	per lin. f
Material,		.17	per lin. f
Total,		$4.65	per lin. f
Forms (2,210 sq. ft.)			
Labor, etc.,		$0.0301	per lin f
Material,		0.0257	per lin. f
Total,		$0.0558	per lin. f

Also detailed data of encasing a brick arch where the bricks wer working loose, as follows:

Handling material,	$ 98.5
Engine service—handling material,	38.9
Excavation, wet (130 cu yd.)	304.6
Reinforcing rods in place,	139.7
Concrete, Class "A" (128 cu. yd.),	691.8
Cleaning up old material removed,	11.5
	$1,285.1

Average cost per cubic yd., Excavation,	$ 2.34
Average cost per cubic yd., Concrete,	5.40
Average cost per lin. ft , Arch,	10.19

This structure was lined with concrete an average thickness of on foot, reinforced longitudinally and transversely with ½-in. twisted bar located 12 in. center to center. In addition to the reinforcement, ¾ i by 12 in. dowels were set in the old masonry a depth of 6 in. at interval of every 5 sq. ft. of surface.

Retaining Walls

The Delaware, Lackawanna & Western reports the partial failur of retaining walls on its lines, both of plain masonry and reinforce concrete. Special mention is made of a reinforced wall 20 to 25 ft. i height, in which, owing to various causes, certain portions were verg ing rapidly on total failure. The method employed in making repairs wa to cut out short sections at a time, bulkhead behind them with second hand timber, clean the reinforcing where necessary and replace the walls Other forms of walls were repaired or rebuilt in much the same manner

The Chicago & North Western reports that where old masonry re taining walls have been crowded forward, some good results have bee obtained by driving piles in the embankment and anchoring the retain ing walls to the piles by means of rods.

The Boston & Albany reports four retaining walls over 200 ft. lon and from 16 to 18 ft. high, running parallel to, and very close to th tracks, which showed signs of failure. These retaining walls wer

strengthened by the use of concrete facing, bonded to the old masonry by 18-in. dowels, spaced at intervals of 4 sq. ft. of surface. The old foundation was from 6 to 12 ft. below the river bed, and in places badly undermined. It was necessary to underpin the old walls, and this was done with reinforced concrete. While underpinning the foundation, it was necessary to shore with 10 in. by 12 in. and 12 in. by 12 in. timbers. While this work was in progress, speed was reduced to 8 miles per hour for all trains. This method for strengthening retaining walls has put them in first-class condition. The tops of the old walls were removed for a depth of 24 in. and replaced with concrete, thus bonding the old masonry and concrete on top as well as on the face.

The Boston & Maine reports having had experience in repairing retaining walls by use of buttresses and grouting at the same time. One case mentioned covered a retaining wall along a river under an important line where the track was close to the edge of the wall. This wall was built of rough ledge stone that had deteriorated to such an extent that in some places there were openings in the wall of a cubic yard volume and larger. As this wall rested on a sloping ledge foundation, 2 in. iron dowels were installed in the ledge in front of the wall and the foundation built approximately 1½ ft. in front of it. Great care was used in removing all dirt and debris from the old masonry as the work progressed and concrete was carried to the top of old wall, being 1 ft. thick at the top. This wall was reinforced about nine years ago, and has shown no signs of failure since. Openings were provided through the concrete at intervals from the bottom of the wall to within 18 in. of the top of the wall to take care of the drainage.

The Baltimore & Ohio has found it necessary to strengthen retaining walls at points along its lines. The most extensive work of this character in recent years was the strengthening of a wall about 20 ft. high, located between the C. & O. canal and the main tracks of the railroad. This was a dry rubble wall of fairly good sized stone. On account of the increase in weight of rolling stock, this wall began to show signs of failure. About three years ago, a section between 400 and 500 ft. long was strengthened by building a reinforced concrete wall in front of the old wall. This past winter, 1100 or 1200 ft. additional reinforcing was done. The concrete placed several years ago was heavily reinforced, and as a result, was quite expensive. The section reinforced last winter consisted of plain concrete. It was necessary to do this work during the winter when the water was out of the canal. At several points where the wall seemed weak, timber braces were placed against it. The foundation excavation for the new wall was removed in 10-ft. alternating sections and was filled to a point that would afford ample protection to the base of the old wall. The intermediate sections were then removed, after which the superstructure was built in sections about 40 ft. in length.

W. F. Strouse,
Chairman.

DISCUSSION

The President:—As the reinforcing of old masonry happens to be quite a hobby with me, I am going to take a little time to recite some experiences I have had.

About ten years ago when I took over the bridges on the Missouri Pacific system I found a good many of the old lines had been handled by promoters, and the bridges in many instances were in very bad condition, and every year there were

large items for new abutments and rebuilding of old masonry and something had to be done. I spent a good deal of time ou on the line trying to find out what could be done at the least ex pense and still make the repairs permanent.

We found on some of the old main lines where stone pier had been built 30 or 40 years ago for pony trusses, that the pier held up the pony trusses all right, but when the bridges had bee renewed either with pony steel trusses or deck girders for heavie traffic, the ends of the piers would settle down or the middle o the piers would break down. As a temporary expedient in thos cases I used an idea that I had gotten from some old bridg man of putting longitudinal timbers from end to end of th pier. That had the effect on the piers under the pony trusses o throwing towards the center some of the load that was settlin down the end of the pier, and under deck girders of throwing ou to the end of the pier some of the load that was breaking dow the middle. That was then followed up, sometimes several year later, by taking down one or two courses off the top of the pie and putting in a new reinforced concrete cap, and I don't know of one case in 10 years on that railroad where I took down a few courses from the top of the pier and put in a reinforced con crete top that would distribute the load over the pier, where w had any further trouble or any further settlement.

We also had cases where the back-filling of the pier behind the casing was very soft and was breaking down under the loads We ran tie-rods through such piers and put a casing 6 to 9 in thick on each side, and we had no further trouble there.

One lesson I learned there was the remarkable bond that forms between new concrete being placed, and old masonry in those piers, even though the old masonry may be moving at the time of placing the new concrete. The first question I was asked was, "How is this concreting to be placed while the bridge is in use and the old masonry moving?" Now in practically every in stance we concreted while the old bridge was in daily use, and even though there was a considerable movement of the old pier, the new concrete set firmly.

This set is really remarkable. Perhaps the most extreme case where a movement has been stopped and the concrete has set was on the long approach to the St. Charles bridge over the Missouri River on the Wabash railroad. There is a long curved approach there, and trains going around the curve would throw

the track out of line sometimes as much as 6 in. The chief engineer of the Wabash finally struck upon the idea of changing these old columns into concrete columns. He put an 18-in. form around them and wound them with wire and rods and built the columns up from the bottom, story by story, from the bottom to the top. When he was a quarter of the way up, one-quarter of the lateral vibration had disappeared, and when he was halfway up one-half of the lateral vibration had disappeared, and when he got to the top the lateral vibration had entirely disappeared. That concrete is apparently just as good as though it had been placed under a bridge that was perfectly still instead of one sustaining a heavy traffic.

Another case I found at Little Rock, Ark., where a bridge across the Arkansas river had piers made up of about 35 ft. of timber cribbing and 45 ft. of masonry on top of pneumatic caissons on rock. The cribs were not really well built in the first place and the sand had leaked out through the cracks. The timbers gradually had crushed and let those piers down, and they were pointing in every conceivable direction. From 1883 until about 1907, when I took over the responsibility for the bridge, I think about five efforts had been made to stop those piers from moving around.

In 1912 we went in and sunk cofferdams about them, went down to a depth of 45 ft., removed all the sand and rip-rap, and while those piers were moving around a good deal, we gradually put in concrete and began to build up, and as the concrete went in one could almost note the disappearance of the vibration. When we got up to the top the piers were solid. When trains went over before, the timbers were soggy, and you could see the water squeeze out of them. When we reached the top of the timbers we put a reinforced concrete shell around the piers, and those piers have been there now for five years and they are just as solid as rock.

In 1907 I had 150 bridges on that railroad under which the piers were moving, for every conceivable reason, and I don't remember one case where we took down a pier or abutment because it was moving. In every case we resorted to some of the expedients reported by Mr. Strouse, and we never hesitated, even on a smooth concrete face of an abutment, to drill in, put in anchor rods and put the shell in front of that.

We had another case where we encased some steel cylinders

in concrete. We had a number of piers, each composed of tw steel cylinders, and each having seven piles driven down throug the cylinders. We wanted to put a heavier truss on and we ha to reinforce those cylinders some way. Without any falsewo at all we went down around those cylinders, drove the piles about 40 ft. penetration by the jet, put the cofferdams down, a came right up around those cylinders and buried them in co crete.

When we jetted a pile down at one side of the cylinder, t cylinder settled about half an inch, so we would drive so ma piles on one side and then go around and drive so many on t other side to keep it from getting too much on one side or t other, and when we got through we found the cylinders, eve one of them, had gone down about 12 to 14 in. The mass of co crete was so great in comparison to the size of the cylinde that the weight of the concrete overcame the motion as it ca up on the cylinders which were vibrating under traffic.

In a number of cases we had concrete arches built for o or two tracks. Sometimes the head-walls were pretty well o at the foot of the slope and pulling away. Now in three cases remember distinctly, I put across the head-walls, about 3 below the crown, a pair of heavy I-beams, and ran rods throu from one set of I-beams to another. On one bridge we were su we were going to lose immediately, we spent about $3,000 pu ting in a set of I-beams and a set of rods five years ago. I to a trip there recently and there has not been a particle of m tion since we tightened up the rods. It is as stable as though had been built right. Nobody sees the arches but the bridge i spector, and he doesn't care, so the appearance does not matt To have rebuilt the arches would have cost $50,000.

Now I hope there are some others here who can say som thing on this subject. I know some of you have had experienc on this that will put all I have had in the shade.

A. S. Markley:—The Chicago & Eastern Illinois had fo through truss spans, each 150 ft. long, and one 166 ft. plate gird draw span crossing the Wabash river at Clinton, Ind. The m sonry supporting this bridge was built of native stone in 187 The stone had deteriorated and began to show defects und the truss bearings on account of the heavy live and dead load For this reason it was decided in 1910 to strengthen all the fi piers, the south abutment and tail wall and a detached tail wa

and to build an additional abutment for a 24 ft. beam opening to replace a wooden trestle for an under crossing for teams at a total estimated cost of $19,490.

The actual cost of this work without overhead charges on car rental was $20,850. During the work the operator was interrupted twice by high water and once to do other important work, which no doubt absorbed the overcharge. Work was begun in September, 1910, and completed in September, 1911, the cost per pier ranging from $3,019 to $2,638.

All of the masonry in the old piers and abutments was veneered with reinforced concrete 18 in. thick.

Cost of concrete per yard for casing:

Material, per yard of concrete	$ 1.84
Labor, per yard of concrete	1.49
Total	$ 3.33
Cost per yard of concrete, labor	6.49
Cost per yard of concrete, material	4.40
Total cost of labor and material (casing included)	$10.89

In order to take care of the additional dead load of the concrete, 30-ft. piles were driven 36 in. between centers around the outside of these piers and the abutment, the latter being 30 ft. long and 42 ft. high from base of rail to low water mark. In driving these piles the leads and steam hammer were suspended below the bridge, a Bay City driver and steam hammer being used. A short boom derrick with a 2-drum and winch-head machine was placed on the front of the driver to handle the leads, hammer and piles. The driver was self-propelling, dispensing with a train crew and locomotive. All piles were driven home to receive the concrete and below low water line. Double rows of the sheet piling were driven around the piers and 2½ ft. away from it, the space between being filled with straw and sand to insure that there would be only dead water inside of the cofferdam to avoid any cement flowing away. The inside casing of the cofferdam comprised the form for the concrete which was placed a minimum thickness of 4 in. outside of the piles, so that no part of the piles was exposed to the atmosphere or other destructive agents. The water around the piles was from 8 to 12 ft. deep. In some cases the piers had been filled around with

broken stone to prevent washing, which very much impeded o work of driving the sheet piling.

In order to deposit the concrete in the water we used a 10- tube made of No. 22 iron, riveted together with a barrow ho per at the top in which to dump concrete from barrows in the tube. In using this it was necessary to seal the tube on t bottom or keep enough concrete in it to prevent the water fro rising in it and separating the sand from the concrete. As t tube was filled it was moved to one side or raised sufficien to allow the concrete to pass out of it in place.

The concrete was allowed to settle around the piles a make its own slope from the inside of the sheet piling down u der the pier. In some cases there were openings that took co siderable quantities of concrete to form the footing up to t grillage, all of which added to the support of the increased de load. The piers in all cases rested on piles and grillage. Wh this work was going on, no discoloration of the water inside t cofferdam was visible, the cement and other ingredients rema ing where they were deposited. These footings, in some cas were 2 to 3 ft. wider than necessary to support the 18-in. vene on account of the grillage being wider than the piers. In th cases we stepped in to the required width. The upper for rested on and were anchored to the footings and were tied the top to prevent their spreading as concrete was deposit in the forms. In order to anchor the concrete to the old pie ¾-in. corrugated bars were placed 36 in. apart. Holes we drilled in the stone 12 in. deep in which the bars were insert They also extended 12 in. into the concrete. After dampeni the holes a rich mortar was packed in them around the bars anchor them to the pier. In addition a dovetailed recess was c in the stretcher course of masonry for the full thickness of t course, from 18 in. to 24 in. thick and as deep as the stone w wide. Stretchers were selected on account of their being narr to minimize cutting. After the recesses were cut, concrete w brought up and an extra thin grout was run into them to fill the voids that appeared in the masonry, which were many a some quite large. As the stone was laid in mortar, where t cesses were not opposite each other, grout would appear on t opposite side from which it entered the pier as the grouting pr gressed. The veneer was properly reinforced in both directio in addition to being anchored to the pier.

Bearing blocks under the trusses on top of the piers were made in the field and were properly seasoned before placing. The joints in the masonry always determined their thickness, the minimum being 4 ft. thick and 24 in. wider than the shoe of the truss. Parallel with the track the blocks extended 12 in. on to the veneer on each end, leaving 6 in. of the end of the block to be covered up with veneer so as not to show the joints of the block on the face of the pier. All these blocks were heavily reinforced and placed under traffic, using a self-propelling derrick to place them. All work done at this time is as perfect as when completed, no blemish whatever having appeared. At the same time new coping was added to all the piers and abutments. At several other double track truss bridges we have had this same defect, bearing blocks replacing the old stone piers where evidence of defects appeared. We have usually coped the entire pier or abutment down in some cases as far as two courses below the coping. We use two 50-ton ratchet jacks under one end of each span with loops made to fit over the nuts of the end pins with stems sufficient in length and strength to carry the weight crosswise of the track. Heavy timber or I-beams were used on top of the jacks to raise the trusses. The stem of the loop passed through the timber with nuts and a plate on top or between the beams.

We had two 12-ft. arches with 6-ft. bench walls in which the stone had deteriorated to such an extent that it was necessary to strengthen them. The barrels of these arches were 45 ft. long. In one we placed reinforced concrete 12 in. thick. In order to place the concrete, which was made reasonably thin, we tapped a hole 24 in. square in the crown of the arch between the two main tracks and outside of the ties in which to pour the concrete, beginning in the center and using 1 in. by 6 in. plank to tamp the concrete in place between the corrugated bars.

At the second arch we used three rings of paving bricks made of ground shale beginning in the middle with centers 30 in. apart or sufficient for men to work between. As the brick was laid in the crown roller ways, the lagging was placed in sections, keeping the brick in reach of the men laying them. As both arches were duplicates we saved $150 by using brick which cost $12 per M. In laying the brick, very thin cement mortar was used. When the brick were "buttered" they would be slid 12 in. to 15 in. on the mortar bed into place, thus insuring

a perfect joint. The space between the old and the new crowns was backed up with spaces of brick and mortar.

We have four or five brick arches which were built in 1896. Upon recent inspection they were found to be as perfect as when put in, except the footings of concrete. There is no leaking of the roofs or bench walls. They were coated over the top with a rich mortar 2 in. thick at the time they were built. No extremes of temperature or combination of freezing and thawing of water have had any effect whatever on their durability.

G. M. Hoffman:—The Philadelphia & Reading has a 14-span Phœnix bridge across the Susquehanna river, in which the piers were giving away below low water. Nobody wanted to undertake the job of fixing them. Finally a mason foreman said he could do the job by digging down in sections, propping up the old stone, and putting in concrete and stone in about 16 sections across, while the traffic was moving It was an unusual piece of work. Each pier was estimated to cost $4,000 but the Reading people did the work for about $2,000 a pier. After each pier was done we ran a lining of about 18 in. around it from low water up to high water. They are just as good today as the day they were built.

R. H. Reid:—Along the line of reinforcing or repairing masonry, we recently had a case where the waterway through a stone arch culvert had to be deepened. It was a culvert built about 50 years ago under an old part of the road. On account of drainage conditions it was necessary to deepen the waterway something over 6 ft. through the arch. The arch was paved and was about 80 ft. long, extending under four main tracks. We underpinned that culvert this year, taking out the paving, underpinning the entire arch, lowering the bottom 6 ft. and putting the paving at that depth. We have just completed the job, with no evidence of cracking or settlement in spite of the fact that it is under very heavy traffic.

We have had many other cases where we have underpinned abutments and piers, and in some cases large arches, with very good results. We are just finishing underpinning a pair of abutments now on one of our branch lines near Fort Wayne. We went down about 4 ft. and underpinned both of the abutments, on account of the lowering of the stream.

We had another pair of abutments about 12 years ago, that were crowding in at a point where the bottom was very soft.

There were three sets of timber bracing between those abutments but they began to show evidences of failure. It was no use to put any more bracing in for the same thing would happen again in a few years, so we decided to underpin both abutments and reinforce them to prevent them from crowding in. We went down 8 or 10 ft. and underpinned both of those abutments, putting enough concrete in front to reinforce them, and we have had no trouble since that time.

On another part of the line some concrete piers that were not properly built in the first place (either the inspector or the contractor, or both perhaps, not being on the job as they should have been) showed evidences of disintegration. We have had to dig them out and replace the concrete under traffic. In some places we took out the pedestals, carried the deck girder spans on I-beams resting on either side of the former bearing point, and put in the concrete, then removed the I-beams and put the pedestals back in place. In other cases we dug out the concrete, put in I-beams and carried the girders on them while filling in around them with concrete. In other cases we riveted one girder to the end of another and carried it in that way.

In still other cases we have excavated below the poor concrete, dug out from under the piers and abutments, taking out all we dared, surrounded them with good concrete and encased the entire top of the pier. In cases where the whole abutment showed evidences of failure, we have carried the girders on falsework, removed a part of the abutment, replaced the concrete and capped the abutment. We have been doing a good deal of that work lately on parts of our line where the masonry is old and not built properly in the first place, some of it being built before we acquired those lines.

PAINT AND ITS APPLICATION TO RAILWAY STRUCTURES

REPORT OF COMMITTEE

To discuss this subject intelligently it is not of as much concern to consider the structure itself, as the material of which it is constructed, and the surface to which the paint must be applied, either for preservative or decorative purposes or for both. From the standpoint of present day construction we can divide railway structures into four classes: (1) wooden or frame structures, (2) brick and stone structures, (3) steel and steel-covered structures, and (4) concrete and stucco structures, although occasionally we may find one put up of any combination of the above.

From the railway standpoint, we generally separate these structures into station and office buildings, dwellings, tool and car houses, shop buildings, coaling and fuel stations, etc.

Wooden and Frame Structures

This class requires the greatest amount of attention and expense, for the only practical method used today to protect these buildings from decay or to improve their appearance is to apply a preservative coating of high grade paint. Aside from the decorative effect the most important function of paint is found in its preservative properties. Unpainted wood will darken, warp, become fuzzy and damp and finally decay, but it may be protected from such forms of decay permanently through the occasional use of high grade paints. Paint acts as a preservative on wood because it closes the openings and pores in the wood and so prevents the entrance of decay-producing organisms. A thoroughly seasoned piece of wood will last indefinitely if kept well painted. This fact, however, is too well understood to require further discussion and we may concede that money spent for painting is "money well spent." Aside from this, an attractively painted railway structure adds a great deal to the general appearance of the road, thus making it an economical advertisement.

The quality and the kind of lumber used in the different structures varies, of course, with the different sections of the country, being governed principally by the type and kind grown in those sections traversed by the individual railroad. The principal woods generally used for siding, outside trim, etc. (i. e., on those portions with which our discussion treats), are usually produced from the softer types of wood, such as white pine (although this supply is diminishing rapidly), hard or yellow pine, poplar, basswood, Oregon cedar, redwood, cypress and spruce.

Gum, white, red and Washington cedar are also used more or less for the purposes mentioned. We are not endeavoring to discuss the merits or demerits of the various kinds of wood, except as they relate to the application of paint as a foundation. Let us bear in mind that these different species and types of woods vary greatly in their make up, porosity and compactness, all of which are important points which are very often lost sight of when the initial or first coat of paint is applied. This operation is commonly called priming. For instance compare white pine and poplar with yellow pine and hemlock—the first being

soft, close and straight grained, even woods, comparatively free fro shrinkage, possessing good absorbing qualities and a ready affinity f paint on account of their even and uniform grain, while the latter a hard, coarse grained, of very resinous and uneven structure, varyi from a soft porous and quick absorbing, to a very hard and fat surfa into which paint can not penetrate Thus we can readly see that a mi ture of proper consistency and balance for the one can not and w not produce the same result in the other, if used in identical ways.

Explained from the practical standpoint, the first requires that t priming coat should be reduced to a medium thin consistency, carryi very little turpentine, or just enough to assist penetration and brus ing. In the second instance a thinner mixture carrying from 25 to percent of turpentine should be used. In the first instance success two-coat work can be obtained, while in the latter case the two-co work can not be recommended as thin coats are absolutely necessa to insure depth of penetration or binding. Three thin coats, w brushed out will not leave an excess of paint on the surface, while t coats which would necessarily have to be heavy, in order to hide cover the surface evenly, may break away or scale in a short tim However, if for any reason two-coat work is desired, the liberal u of turpentine in the priming coat is recommended, as well as amp drying time between coats. The priming coat should be applied wi a full brush, and spread out well and evenly. Do not allow the bru to slip over the hard places, but work the paint well into them. Ext care should be taken in brushing over this surface in order to even the priming and not have too much pigment on the hard parts.

We now reach the point, which is sought to be conveyed from t foregoing. Nearly every railroad has adopted a certain standard painting, both as to method and colors, including the formulas compo ing the different mixtures. These mixtures, or "standard colors" a usually bought in the open market, although some concerns ha "paint mixing departments" of their own. In a great many cases t material is bought "ready application," leaving no room for adjustme to fit the different surfaces, and of course it is applied in the conditi in which it is received. Or on the other hand, incompetent or inexp rienced men who neither know nor care what they are doing, are appl ing the material in any old way and manner and when trouble develo later, the question is "Why?" Such a condition is generally found railways where carpenters and bridgemen unfamiliar with such wo take care of the painting.

Priming

The act of priming or first coating is the most important operati in painting, although in many cases it is not so considered, which a vital mistake. The priming coat applied to any surface must fill a satisfy this surface, and create a foundation upon which all future coa can be applied successfully. It holds the same relative position painting as the foundation of a house or bridge does in constructio It must last and hold the superstructure as long as it remains. It mu carry sufficient linseed oil not only to satisfy the surface, but also to bi and hold the pigments to this surface. Priming mixtures must al carry the proper amount of turpentine to cause penetration and assist forcing the oil and pigment into the surface by absorption. The fo mation of the pigment must be such as to allow penetration into t surface, and above all, it must be well and evenly spread and brush into the surface. It is of course impossible to erect a frame structur and have all of the lumber of the same absorbing qualities. The sa wood absorbs paint more rapidly than the harder-grained portion However, this does not necessitate a different reduction for each ki of grain in the same lumber, but it does require proper judgment on t part of the painter in correct application to such a varied surface. I

priming soft wood, the paint should be applied with a full brush, and enough paint used at all times to satisfy the surface. It should be well brushed, especially on the harder grain, in order to force the paint into this close grain, and so remove, by diligent brushing, any surplus paint that remains on the surface. On hard or close grained wood a medium full brush should be used in application, for this class of wood does not possess the absorbing properties of the softer kind, and therefore requires more brushing to force a sufficient amount of oil and binder into the wood and at the same time not leave an excess of paint on the surface. If the priming coat is of the proper consistency, carrying sufficient pigment to fill and hide the grain, and is well brushed into the grain of the wood, most of the absorption will have ceased with this coat, and no excess of pigment will be left on the surface. This thin coat will then allow the next coat to penetrate through and satisfy any part of the wood which was not fully filled at the time of priming, and will also allow the second coat to bind itself to the wood and combine with the priming coat.

An excess of paint on very porous woods will cause peeling or chipping, for this heavy coating prevents the oils from penetrating the wood and then fails to assist in holding the coat on the surface. The oil and binder in the second coat penetrates into this heavy coating only, and does not reach clear through into the wood to assist in forming one solid film, well anchored to the surface.

Paint, heavily applied to a hard or close-grained surface, will dry with a gloss, forming a hard glaze over the surface, into which the second coat cannot penetrate to any depth, and will only fasten itself to the outside of this hard glaze coat, whereas it should go clear through to the wood in order to help anchor the second or subsequent coat. The prime coat should not stand longer than is necessary to harden the film thoroughly, and allow for full absorption and penetration. If allowed to weather, this priming coat will become porous and absorb the life of the second coat and there will not be sufficient binder left to adhere to the surface properly.

The foregoing demonstrates plainly that the man behind the gun, in this case the painter, must do his bit by exercising good judgment and proper skill both as to material and labor in order to turn out successful work. The conscientious, capable and careful workman will exercise at least as much if not more care and skill in the application of the priming coat, than he will with the finishing coat.

Finish Coats

Usually railway standards and specifications stipulate whether two- or three-coat work is desired, but it should be borne in mind that in trying to finish in two coats over dark, hard and pitchy lumber, especially with light shades, success at some future time may be sacrificed. In the second and finishing coating of structures, care must be exercised in spreading the paint evenly and clean and in avoiding sags and curtains.

Brushing

Proper care and knowledge in brushing is as necessary as good paint for successful work, for on the working or brushing of the coat rests, to a great extent, the success of the material used, regarding wear and durability in its protection of the surface to which it is applied. It is a fact that the best material, in the preparation of which great care has been exercised, will not give good results if it is improperly applied.

Paint loosely applied and flowed on to the surface, will not bind to it, neither will it dry or harden properly, and a coat of paint not properly bound to the surface over which it is applied, will be found hard

and dry on the outside and still not evenly hardened throughout. C sidering the entire matter, it is evident that the right kind of mechan should be employed, for practical experience embodies the proper s and knowledge so necessary to success.

Shingle Roofs

Shingle roofs, at least on the better class of buildings, ought to painted with some high grade material, not only to preserve the r itself but to improve the appearance of the structure as well. Mo over, a valuable characteristic of high grade paint is its resistance fire. While the oil content is more or less combustible, there is pr ent in the dried paint film a minor proportion of oil, the major p tion consisting of metallic and mineral pigments which are unaffec by fire. The content of pigment varies from about 50 per cent to per cent. The application of paint to roofs will preserve them fo number of years and render them more resistant to fire, making it inexpensive form of preservation insurance.

Paint

This is really a subject of itself so it is not necessary to enter i a discussion of it here, for it is usually covered by the standards p scribed on each railroad. However it may be well to call attention ag to the importance of procuring the material heavy enough, in or to give the mechanic a chance at its proper reduction to insure corr manipulation for the several coats, both for new work and for recoat over old films.

Brick and Stone Structures

With the exception of window and door frames, sash, doors, gutt and down spouts, no painting on this class of structures is really n essary. The method and the color are generally covered by the sta ards in vogue on each system. If, however, it is desired to paint brickwork, etc., the usual rules will govern the operation.

Steel and Steel Covered Structures

On this class of structures, the primer or first coat must be selec judiciously. If the standard finishing color for these structures sho happen to be of a carbon or lamp black base, it would be positiv wrong to use such a paint for the ground coat applied directly up the steel. This primer should be a properly-prepared rust-inhibit coating, from basis pigments such as red lead, sublimed blue le oxide, chromates or similar inhibitive materials. After proper dry time has elapsed, carbon or other standard paints may be applied s cessfully Over such a ground practical tests have proven that ultim economy is effected by using only the highest grades of the pro kinds of paint for metal protection.

Cement and Stucco Structures

Structures of this class are of more recent origin than the othe and it may be some time yet before paint will be extensively used them. But at some time this type of railroad structures will rece attention to a greater or lesser degree by the application of pai Owing to the limited time, this committee has not been able to work data of actual experience on railway structures to date, but will quo briefly a well known American authority who has conducted numbe less tests in all its phases along this line, Mr. Henry A. Gardner.

" Portland cement is used for numberless types of construction from concrete factory to the stucco dwelling. Its strength and durability are, however, offset by its unpleasing appearance, especially during stormy weather, when it absorbs large quantities of water and becomes mottled and streaked. At such times the interiors of concrete buildings are apt to become damp and cold. The rough exterior surface will receive and retain particles of dust and soot deposits from the air.

" When paint is applied to a concrete structure the exterior pores are filled, and a smooth, rubber-like film results that prevents the admittance of rain. This alone should constitute sufficient reason for painting cement constructions in every locality. The dust-resisting properties and the ornamental character of painted cement should be the further consideration wherever there is civic pride.

" Fortunately paint will wear upon cement for as great, or even greater periods than upon wood or iron, provided the paint is applied when the cement is dry. Moreover, the same paints that give good service on wood may be used successfully upon cement."

From tests and experiments made for a number of years it appears that high grade composition linseed oil paints with lead, zinc and inert bases are giving excellent results on concrete. That being the case. practically the same rules as given for the other types, should govern here with but few minor changes.

Chas. Ettinger, Chairman.

DISCUSSION

A. S. Markley:—I would like to ask what is meant by sags and curtains in paint.

C. Ettinger:—That is a technical expression. Suppose a girder sags, you know what that means. A curtain is what they call a run with another run below that—stuff thrown on and left to run.

L. Jutton:—Will the heating of paint assist in its penetration of wood?

C. Ettinger:—It all depends on weather conditions and on the surface. You should not heat the paint for you destroy the most valuable article you have in it—the oil. It is a well-known fact that the most valuable ingredient of paint is the oil; pigments alone do not wear.

A. S. Markley:—Isn't the oil giving away much of the cause of paint peeling off?

C. Ettinger:—No, there are a number of reasons why paint will peel off. In 95 per cent of the cases it is due to improper judgment on the part of the mechanic, or to the material; or it may be partly due to the priming in building the foundation. The reason that I want to bring this home to every railroad manager is that paint is usually bought in the open market, and is usually ready for application, giving the painter absolutely no chance to manipulate the paint to suit the foundation to which

he must apply it. Now, you use a good deal of yellow pine your road, don't you?

A. S. Markley:—Yes, pretty near all yellow pine.

C. Ettinger:—Well, there is a great deal of pitch in it there will be very little absorption,—the surface being so fa That timber contains a great deal of resin and pitch. All s woods as that require special manipulation both by reducing paint properly, as well as by proper brushing. You have go work it in. It will not anchor to the wood if you don't. Th paint shrinks in drying. The moment it shrinks, it pulls a from the foundation, and later, when the oils have gone, it cra open and finally drops off. That is what we call peeling.

A building ought by all means to be permitted to sea before the painter goes to it, but everybody knows that no considers the job completed until it is painted. When the penter is through the painter must be right behind him. Thi absolutely wrong.

G. M. Hoffman:—Do the same conditions exist on bu ings away from the railroad as they would along the railr with reference to painting? You do not have nearly as m soot to contend with on a building away from the railroad, w a building near the road will be covered with it. Is not harder on paint?

C. Ettinger:—Yes, the gases contained in the smoke are hardest on paint of anything you can find.

G. M. Hoffman:—How often do you paint your buildi along the railroad?

C. Ettinger:—All the way from three to six years.

G. M. Hoffman:—How many coats do you put on?

C Ettinger:—That depends upon the wood and the co but by no means should one-coat work be done. I don't beli in one-coat work, for the reason that in order to have any k of an appearing job you have to spread the paint so very he to cover it. You have a good deal of oil and no binding this leads to a separation between the old paint and the new.

G. M. Hoffman:—Fifty per cent of the railroad buildings buildings along the railroad, don't need painting, just cleani But when you start to paint a railroad building what wo you do first?

C. Ettinger:—Well, the cleaning method generally used to just dust it.

G. M. Hoffman:—You wouldn't wash it; wouldn't try to get the black dirt off? Would you expect to get good results from that, putting the paint over the soot and grease?

C. Ettinger:—Yes.

G. M. Hoffman:—I don't agree with you. Every two or three years we go along the division and clean the buildings, making a general cleanup. If a building needs washing, we wash it and scrub it and then paint it. If one coat will do we give it one, and if it needs two, we give it two, but it is very seldom we give it two coats. I claim that paint won't hold very long on grease and soot.

C. Ettinger:—If you use a sufficient amount of turpentine, it will penetrate the soot, and make the best paint out.

THE ECONOMICAL DELIVERY OF WATER TO LOCOMOTIVES

COMMITTEE REPORT

Strictly speaking, the economical delivery of water to locomotives includes every operation involved in handling the water from the source of supply to the locomotive tender, but for the purpose of this paper it will be interpreted to include only the delivery of water from the storage or roadside tank to the tank of the engine.

Water is delivered to the tender of a locomotive either directly from a storage tank or through a pipe line and a discharging device, commonly called a water column, standpipe or penstock. In the early days of railroading water was delivered direct to the engine tenders from the pumps, which were chiefly operated by hand by switchmen or other employees when not engaged in other duties. Later horse power was employed and in time storage tanks of small capacity were constructed and water was delivered to locomotives through leather hose or boots, as they were then called. Metallic and rubber tank fixtures followed and finally the sway spout and tank valve came into use. Many different types of spouts and fixtures were evolved, none of which can be said to give entire satisfaction, even to the most improved tank fixtures of today.

The earlier types of tank spouts were fitted with ball joints and also with rubber hose connections. These fixtures were a continual source of annoyance and expense, especially in the colder climates where they gave much trouble from freezing. Spouts of more simple form were then devised, the spout being considerably larger than the goose neck or outlet pipe, which permitted a more liberal water passage and overcame the necessity for a water tight joint between the outlet pipe and the spout. This type of spout was also more simple in construction and repairs than the close fitting joint and is still in general use with but little modification in design.

Penstocks or water columns have taken the place of tank spouts to a large extent in modern installations of railway water stations, largely because they permit a more convenient location of the tank and also the taking of water at several points. The desirable qualifications in a penstock are a rapid delivery of water with low frictional resistance to the flow of water, and a valve movement that may be handled and controlled easily without water hammer. The construction of the penstock should be such as to permit it to be operated easily and to be economical in maintenance. The importance of the time element in train service requires that the delivery of water to the tender be made as quickly as possible. For this reason the waterways should be of ample size and the flow of water through the column as direct as possible.

The following paragraph on the discharging capacity of penstocks is taken from University of Illinois bulletin No. 21:

"Since the head available in a water column depends upon local and other conditions, and the economic problem is so varied, the selection of a limiting or maximum velocity of flow upon which a general design may be based can not be made. However, it is evident that the economical velocity through a water column and also through the supply main will be much above the limiting velocity used in ordinary waterworks practice where continuous flow throughout 24 hours and the cost

of pumping against the friction head of long lines of mains combine make the economical velocity less than 5 ft. per second and sometim as low as 3 ft per second. Aside from such considerations as the co of pumping and the giving of sufficient elevation to the supply tanks, t maximum velocity allowable through a water column will depend up such matters as the satisfactory operation of the valve and the effe of closing the valve in the production of water hammer in the supp main. From a study of these tests and a comparison with water-wor practice, it would seem that with a short line of pipe from the supp tank a velocity through the water column of 12 or 15 ft. per second m be considered as the maximum desirable for ordinary conditions, a for longer lines the limiting velocity should be smaller. For a lo line of supply main the limit of allowable velocity would be perhaps low as 8 ft. per second. It would seem, then, that 3,000 gal. per m for an 8-in. water column, 4,000 gal. per min. for a 10-in. water colu and 6,000 gal. per min. for a 12-in water column may perhaps be co sidered to be the limit of desirable flow through water columns. would also appear that a loss of much more than 20 ft. of head for t discharges just mentioned may be considered to be excessive, und conditions of ordinary tank supply."

The principal advantages in the use of penstocks or standpipes a that they permit the selection of a permanent location for a tank remo from the tracks and out of the way of future construction and th they make it possible to deliver the water to locomotives from a sin storage tank at as many different points as may be desired. Other a vantages are that they do not obstruct the view of signals, etc., th offer better drainage and thereby cause less trouble from soft track a ice in winter, they are less liable to strike trainmen and cars than a spo suspended over the track and they may be protected from freezing mo readily than the gooseneck and valves of a tank.

The earlier penstocks were of the rigid-spout type, which permit a radial movement only, the delivery of water being controlled by gate or globe valve. The necessity of a flexible connection was soon a preciated and the spout connection was made with a flexible connect to the upper elbow. As with the earlier type of tank spout the ma facturers of penstocks endeavored to maintain a water-tight joint at upper elbow and at the same time provide a vertical as well as a rad movement of the spout. However, the maintenance of this joint v difficult and expensive, and in 1904 what was known as the Fenner d spout was put on the market. This consisted of a spout with the up elbow telescoping into the end of the spout far enough to prevent a water splashing out of the opening. The open joint of this spout only gives a great range of adjustment, but prevents ice from form in the joint. This form of spout is provided with practically all mod makes of penstocks and is a decided improvement over the rigid sp as it has a wide range of adjustment in a perpendicular line with discharge end always in the center of the track and a lateral movem according to the length of the spout. It can be swung out or in, creasing or decreasing the length of the spout to reach the center of track in the event that the penstock is located between diverging tra or tracks at different distances from the penstock and avoids the cessity for spotting the engine accurately when taking water. Anot advantage in the telescopic spout is that it lessens the liability of penstock being knocked down, owing to its greater flexibility and this way reduces the maintenance cost.

It is important that supply lines leading to penstocks be desig properly. A penstock operating under a low head should have a lar pipe than one working under a relatively high head The same th is true of a long pipe line If the maximum delivery is desired the s ply line should be at least two inches larger than the penstock. Wh several penstocks are installed in a busy yard or where more than

engine will take water at the same time the supply line should be large enough to supply water to more than one penstock without any material decrease in the delivery. A 12-in. penstock with a 14-in. main 1,000 ft. long will deliver 4,000 gal. per minute with approximately the same loss of head as a 10-in. penstock with 1,000 ft. of 12-in. main delivering 2,750 gal. per minute or an 8-in. penstock with 1,000 feet of 10-in. main delivering 1,750 gal. per minute.

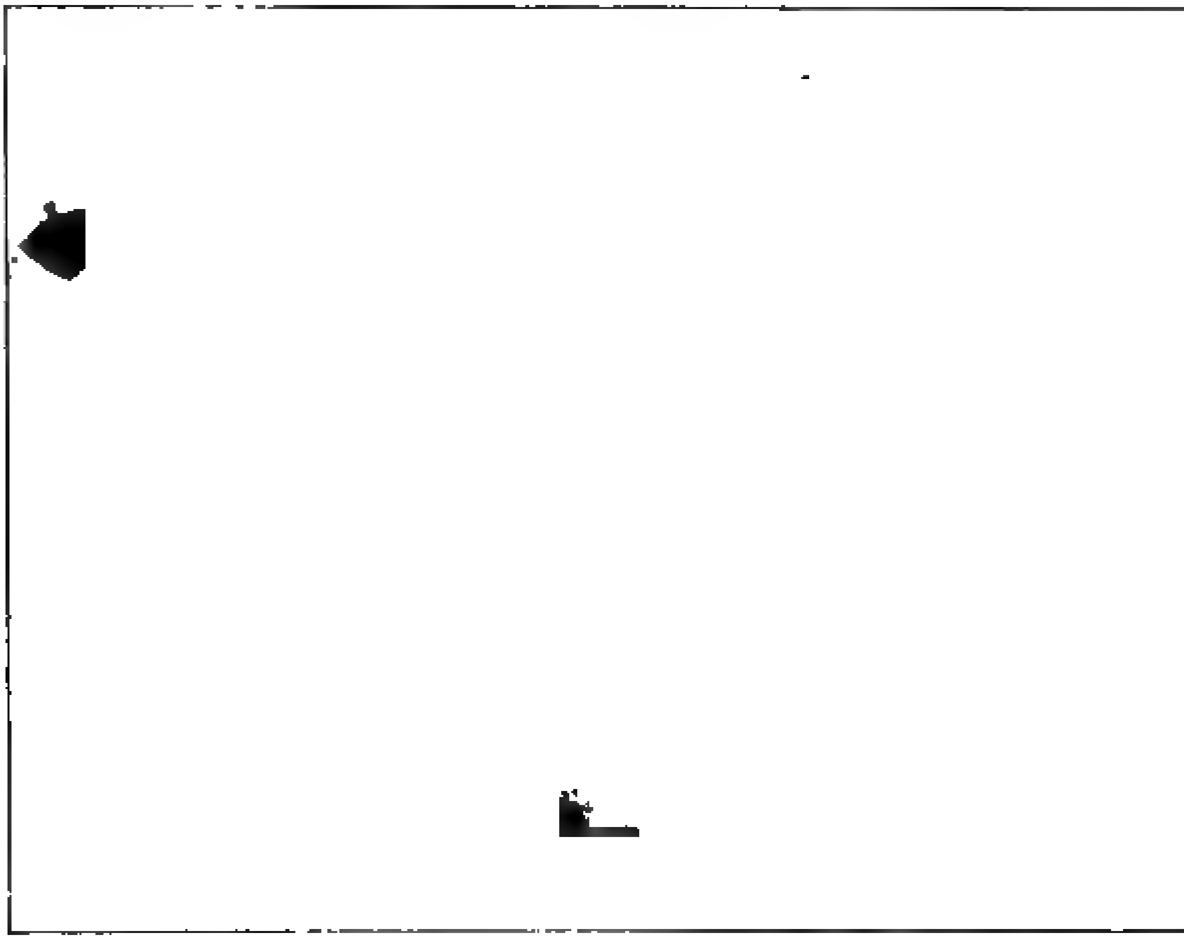
A distance of 20 feet from the top of the rail to the bottom of the tank is generally accepted as the economical height of tower for tanks. A higher tower is not economical on account of the increased cost of elevating the water to the greater elevation, while a lower tower does not furnish sufficient head for the larger engines with high tenders. It is also essential that the tank itself should be within narrow ranges of elevation, to avoid any considerable variation in pressure, as a balanced valve such as used on modern penstocks operates most satisfactorily under a uniform head.

The proper location of penstocks is an important factor in the economical delivery of water. At engine terminals they should be located conveniently so that an engine may take water along with other supplies such as coal, sand, etc., without any switching or back-up movement. Penstocks serving yard engines should be so located that they will not interfere with the movements of road engines handling trains or with the movements of engines to and from the roundhouse. In a large yard it is important that the engines do not block the switching lead when taking water, the proper location of penstocks being at each end of the yard where engines may take water after receiving their trains. In a large yard this may mean a heavy expense for pipe lines, but where there is a frequent train movement the expenditure will be justified by cutting down the terminal delay and facilitating the movement of trains. Where the distance from the main supply tank is very great, as for example at an isolated penstock at the far end of a station or yard layout, it will frequently prove more economical to locate an auxiliary tank opposite the penstock as the supply would be taken by gravity from the main tank through a much smaller pipe than if the engines were supplied direct from the main tank through a penstock main. This is especially true with the present high cost of cast iron pipe. For example the cost of laying a 14-in. main will be nearly double that of an 8-in. main and the difference in cost of 2,000 ft. of pipe will more than pay for a 100,000 gal. wood tank. Where water is pumped by company forces the additional storage will frequently dispense with the services of a night pumper and guard against delays on account of breakdowns.

An important feature in the economical delivery of water to locomotives is the prevention of waste while taking water. This is sometimes due to carelessness on the part of the fireman, but more often is the result of faulty fixtures and improper design of the manhole on the engine tank. The great range in the height of manholes above the rail makes it a very difficult matter to provide fixtures that may be adjusted to the varying heights unless the manhole is of liberal size. This is especially true of tank spouts. The manhole should be rectangular in shape and not less than 16 in. wide and 30 in. long. It will be found that when taking water with a spout without lateral adjustment, the spout will be at the outside edge of the manhole on high tenders and near the inside edge on low tenders. Thus it will be seen that it is impossible to avoid a waste of water with round manholes unless they are of uniform height above the rail.

C. R. Knowles,
L. A. Cowsert,
H. A. Horning,
M. D. Miller,
R. C. Henderson,

Committee.

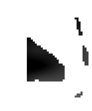


Typical Flexible Spout Water Column

Star Operating Device

Anti-Splash Nozzle

Apparatus for Rigid Spout Water Columns



Typical Rigid Spout Water Column

DISCUSSION

B. F. Pickering:—I ought not to presume to presen minority report, but I am going to do so just the same. In experience we have not found the telescopic spout economi The cost of maintenance has been so high that I have repla it with a rigid spout on six of our 12-in. standpipes. This not only proved economical, but it has always been very sa factory in the delivery of water. We have a spout which what is called an anti-splash nozzle, which consists of a sn grating at the outlet of the spout that breaks up the swirling tion of the water so that it descends in one solid colu With that device we have no difficulty in taking water eit with a very high or a very low tank. At almost all of our 12 and at some of the 10-in. plugs, I have an extension about 20 long, hung by a chain from the bottom of the spout. With ceptionally high tanks this is swung out of the way, w the water is being taken, but with the low tanks it is alw in position. However, even without the extension I find we can deliver practically a solid column of water even to extreme ground or outlet of the drain under the pipe with type of spout. We found that the telescopic spouts were expensive in maintenance because of rough handling, wh we found it impossible to control. The spouts were continu being broken in one way or another. Frequently it was back casting of the spout that would be ripped off by the ch chains, the fireman pulling them down too hard. The r spout is much more simple, with no parts to get out of or and we have found it far more economical.

G. W. Andrews:—I had not expected to say anything this subject, because of the fact that Mr. Knowles' paper covered the ground so thoroughly that I felt it would be less to say anything, either in defense or favor, but since Pickering has made his statement of the advisability of abol ing the telescopic spout, I feel called upon to say someth Mr. Pickering has a perfect right to put in his minority rep but he holds that he has no trouble with the rigid spout, o than the width of the manhole If the engine stops at the r angle the rigid spout will deliver all the water he wants, bu it is 3 or 4 ft. ahead or back, only a small quantity of w

will go into the tank, while an immense amount will go down on the track. I don't think anyone will try to deny the fact that the telescopic spout is more expensive to maintain than the rigid type. Possibly a locomotive is more expensive to maintain than a wagon, or an automobile than a wheelbarrow, but if you want good results, you must expect to pay more for the maintenance. I therefore believe that ninety per cent of the members using telescopic spouts will say that, under all conditions, the rigid spout can not be compared to the telescopic spout. There is one more thing that I want to say in this connection. We have used on our road practically every method that has ever been used in the United States to get water into a locomotive tank, commencing with dipping it out of the stream with a bucket (which goes back a little further than Mr. Knowles' statement that it was pumped by hand). It was dipped out of the stream and poured into a barrel resting on the little truck car which carried the locomotive. We still have one of those which we keep to show what we had to do in the early days. We have used all types of engines from that to the Moguls of the present day, and it has been the trend of our custom to eliminate a rigid spout wherever possible.

C. R. Knowles:—The rigid spout penstock is undoubtedly simpler in design than the flexible or telescopic spout and while the original cost of the telescopic spout is greater than that of a rigid penstock the maintenance of the telescopic spout should be less for the reason that the rigid spout is more liable to damage. For example: If the fireman is careless in bringing the spout around before the engine has been spotted properly it is likely to strike the corner of the cab or car. The flexibility of the telescopic spout will permit it to glance off without damage, which would not be possible with the rigid spout. Our experience has been that the damage resulting from the knocking down of the telescopic spout is only about 20 per cent of that to rigid spouts.

Mr. Pickering probably has local conditions which account for his preference for the rigid spout. I gather from his remarks that his engine tenders are of more uniform height which eliminates the necessity for a wide vertical adjustment of the spout. I cannot understand why his firemen cannot handle the telescopic spout quite as readily as the rigid spout. We have colored firemen through the South who handle these spouts in

taking water, and we find that they have less trouble than
the rigid spout.

As Mr. Pickering says, the anti-splashing device is a
tageous in directing the water through the manhole wit
rigid spout and we use it quite extensively. The troub
have found with the anti-splashing device in the Northern
tude, is that ice will form in the upper column above the
stock pit and a thaw will cause this ice to accumulate o
anti-splasher, resulting in the water lifting the penstock co
out of the valve chamber. We have a number of the Va
bilt type of circular tanks in service with which it is very di
to use the rigid spout. The tender has a height of 13 ft. t
top of manhole, while the grab-irons extend 18 in. abov
manhole. This means that it is necessary to maintain a
cal clearance of 14 ft. 6 in. Other tenders have manholes
or so above the rail, so you can imagine the difficulty of a
man attempting to operate a penstock 6 ft. above the ma

The telescopic spout has a wide range of operation
cally as well as radially. A barrel may be placed in the c
of the track and filled with a telescopic spout having a
vertical clearance without any waste of water. While ther
some roads that are using the rigid spout exclusively, I
it is very conservative to say that 75 per cent of the
stocks being installed are of the telescopic spout type.

B. F. Pickering:—If I listened correctly when the c
man was reading this report he made the point that the
scopic spout was more economical. Mr. Andrews says, " N
will claim that the telescopic spout is more economical."
two statements don't harmonize.

We have no difficulty in spotting the engine correctly
to get the outlet of the spout directly over the manhole. O
road it is an inflexible rule that all freight engines shall b
off from their trains before they take water. It is a very
matter then to spot the engine correctly. We found in
cases that through passenger trains were not spotted care
when we had the telescopic spout, and we also found tha
ranging of the spout to one side far enough to accommo
the manhole of the tender invariably caused an overflow a
joint, or leakage enough so that the track was flooded, w
means a whole lot of expense in the winter time in our
country, because it keeps somebody picking ice at the st

pipe practically all the time. The particular make of spout which we had might have had something to do with that. I have had experience with only one type of telescopic spout, but we certainly consider that type to be far less economical than the rigid spout. We consider the rigid spout better in every way, and we have very much less trouble with overflowing and icing the tracks with it.

And as to the height of the engines, our spouts are set so that the outlet is 14 ft. above the rail. This accommodates the largest Pacific type engines and the large freight engines, as well as the small switchers which sometimes take water at the same plug, but not extensively, because our large yards are nearly all supplied also with smaller plugs which do not have as high a range. With the type of spout which we use we have had no complaint because of their being unable to operate them all right. I think the great range between high or low tanks is maintained as much, perhaps, on our road as any. We have some of the real old types of engines and we have a few modern ones.

R. C. Sattley:—I want to ask if you have any columns broken on account of the rigid pipe?

B. F. Pickering:—No.

R. C. Sattley:—The reason I asked that was that I put in the first two standpipes, I think, that were ever installed on the Northwestern at Sterling, Illinois, and they were of the rigid type. I think we replaced one of those about each week. At that time we did not have a rule requiring the cutting off of freight engines when taking water, and we had much trouble from breakage of those columns. The extension of the pipe would come in contact with the first car. We used to blame the engineers and firemen for not liking the standpipe and we thought that they were trying to do away with them, but we know that isn't so now. We afterwards installed a short section near the bottom which had a crease in it which would break first. Hence when breakage occurred all we had to do was to replace the small broken section and be operating again very quickly.

B. F. Pickering:—I will say that we have had no trouble along that line in recent years. Formerly we had a very much smaller standpipe and we did have a great deal of trouble with it, but it was before the order was promulgated that a freight engine must be cut off from the train in order to take water.

We have had difficulty with ice forming on the anti-spla nozzle, or rather caking there, after it had formed on the m of the spout. We have had a 12-in. spout lifted out of socket by the pressure, but we have taken care of that by stalling a relief valve, which I think should be placed on e standpipe. When that is adjusted properly we have had difficulty whatever with the ice caking on the anti-splasher zle and lifting the spout out of the socket.

A. S. Markley:—I agree with what Mr. Pickering has in regard to the rigid standpipe. We use them on the Chica Eastern Illinois and they are doing well. I noticed in par lar the complaint that more water is wasted with the rigid with the telescopic spouts, but I have noted cases wher much water was wasted and as much ice accumulated w the telescopic spout was in use as with the rigid spout. Al gines should be separated from their trains when taking w and the standpipes, when not in use, should stand in the d tion that trains move on double track. Then if the engine i cated anywhere near right and the pipe is swung over the hole, there will be no trouble about the water not going into engine tank. We have all rigid standpipes on the Chicago sion except two. We keep a duplicate outlet spout at each st pipe and a damaged spout can be replaced in a short time. rigid spout is the cheapest to keep in repair.

C. R. Knowles:—There is little to be said in regard to maintenance cost of penstocks. It might be true of any divisions equipped with the same type of penstock that the of maintenance would be much greater on one than on the o There is no doubt that firemen are being interested to a gr extent than in former years which lessens the damage to stocks through careless handling The cost of maintenance be determined by the care the penstock receives in opera and also the care used in maintenance The penstock ma carelessly erected, the cables allowed to rust, etc. Any w from the telescopic spout is due to carelessness or poor sign; in some instances the vertical clearance is not suffi to permit water entering the tender without splashing out butt end of the spout. Even with a 36 in. manhole, as menti by Mr. Markley, it will be found that there will be some w when the engine is spotted four or five feet out of line on count of difficulty in bringing the rigid spout over the man

In regard to the spout being turned in the direction of traffic,—this is possible only on double track or on passing tracks where the movement of trains is in one direction.

W. E. Alexander:—I think Mr. Knowles' reference to economy was partly in regard to water. If you waste water in any form, it is a loss, and the economy of a standpipe is materially lessened. However, there are other methods of taking water from standpipes that have not been mentioned. We used a different form of standpipe from either of those mentioned. The form we used first had a flexible rubber joint on the standpipe, which allowed the spout to stand up pretty well when it was released, and it would swing over and come down to the manhole. It is a very good pipe, in fact, I think it is next to the telescopic. So far as the rigid standpipe is concerned, we have never used any and so I can not say much concerning them. It always seemed to me that the anti-splasher would be the only thing that would allow them to be used.

We have another joint that was introduced later, a metal joint, packed with a round packing, but it is unsatisfactory in a cold climate. It freezes and this tears the packing, so that invariably the joint will get to leaking. We are trying, as far as possible, to discard that make of joint.

J. Dupree:—If the firemen, after shutting off the water, would wait a few seconds before turning the spout, so much water would not go on the track; but they will not do that. The trouble is that 99 per cent of the firemen are careless. They even neglect to cut the engine off before taking water. They handle the penstocks in a reckless manner. If penstocks were properly handled there would be but few repairs necessary on either type of spouts.

C. R. Knowles:—The reason for having the engine cut off from the train in taking water was not primarily to protect the penstock, but to save drawbars in attempting to spot the engine while coupled to a long train. With the use of the telescopic spout it is immaterial whether the engine is cut loose from the train or not, so far as the penstock is concerned.

P. J. O'Neill:—I have studied the maintenance of standpipes very closely. I have been trying to convince our people how much more economical the telescopic standpipe is than the rigid or the flexible joint. If I had the figures here, I could show where, for a term of eight years, I maintained telescopic joint

standpipes at a cost of 27 cents per month per standpipe for
period of eight years, as against $4.28 per month per stan
pipe for the rigid type. I found the rubber jointed type to
the most expensive I had to maintain.

I have no trouble with the wasting of water with the fle
ble standpipe, that is the telescopic spout—while with the rig
standpipe there is always a stream of water or a streak of ice
both directions. The rigid standpipes I have had in use were
the two-man type, where one man down below turned the val
and the other one took the water. However, it was so mu
easier to swing the pipe around before telling the man down b
low to shut the valve off, and consequently that is what he did.

I have never had a telescopic spout knocked down by an
thing other than a wreck, although I have had two knock
down by wrecks. I have had a great many of the rigid spou
knocked down, and also of the type with the rubber sleeve in
Whenever a train of cars releases and the slack comes down
the engine when it is taking water, at a flexible spout it is goo
by standpipe, always. We have orders that engines shall be c
loose from the trains when taking water, but it is ignored mo
than otherwise. They observe the rule on the main line, but
the branches they don't.

J. B. White: -A great deal might be said in favor of t
more modern penstock; in the first place, on a great system
have a difference in the height of engine tanks of from 4 to
ft., from the small switchers to the large freight engines who
high coal racks sometimes make it very hard to get the rig
spout around. I have seen firemen take hold of the spout
lift it over the coal and break it off at the break joint. You m
say that this is impossible, but when you stop to think of
12-in. pipe, 12 to 14 ft. high, with no bracing whatever above t
platform, and a leverage on the spout of 12 ft. you can read
see how easy it is to break it in frosty weather. Sometimes t
fireman has the engineer pull up to allow the spout to pass, e
pecting to push it around as the engine moves by, but instead t
coal rack strikes the end of the spout with a little jar and ov
it goes. One might say, "Why did he not turn it the oth
way?" He could not, for the roof of the car next to the engi
would not allow it, and to detach the engine from the coach
would cause a delay.

I have heard mention made of anti-splashers and buckets

tween the end of the spout and the tank. These are all right for low engines. Nevertheless, on very windy days you will find complaints from the fireman about getting wet when taking water. In some instances in order to be able to take water a high engine will unhook one side of the bucket and leave it that way, and as it is too much trouble for the fireman on a low engine, to hook it up, the company is put to the expense of sending a repair man 100 or 150 miles to hook up the bucket.

On the trunk roads where one has to figure on delivering water to engines which take from 6,000 to 8,000 gal. in 1½ to 2 min. it is absolutely necessary to have everything handy and convenient for the fireman so he can make every move count. Also, with the rigid spout, we have experienced considerable trouble during the winter in keeping the valve rods properly adjusted, on account of frost heaving the penstock platform, thus giving the effect of shortening the rods and not allowing the valve to open properly. We have to adjust the rods accordingly; then, when spring comes, we have to go over them again or the valve will not close. This is very expensive on a large system. You might say that we use concrete for pits, but I have seen a solid 12-in. wall with a concrete top break in two and heave 4 or 5 in. The best remedy we have found for this is to dig a ditch 2 ft. wide and 5 ft. deep around the outside of the pit and fill it with cinders, although where there is a great deal of water this has not always been a success.

C. R. Knowles:—I attempted to prepare comparative figures on the cost to maintain telescopic and rigid spouts but must confess that when the figures are secured one can argue either way as to maintenance. The figures on maintenance, as I have said before are influenced to a very great extent by the care in handling and maintaining the penstock. Some four or five years ago we had the question up of changing the design of our penstocks. Accordingly three different types were installed at one of our terminals. I do not think that we have spent $10 a year on any one of them notwithstanding the fact that they have been in service five years.

R. J. Bruce:—We have tried about all kinds of standpipes there are on the market, and we find the flexible joint, with the rubber connection gives a great deal of trouble. It breaks very easily in the winter. We have also used those with ball and socket joints, but they leak and freeze up and give a great deal

of trouble, so we have adopted the telescopic spout largely b cause of the benefit to the transportation department. The tra crews can take water with less trouble in spotting the engine While we have orders to cut off the engine to take water, th seldom ever do it.

As far as the upkeep is concerned, I don't think there very much difference. Our experience is that the telescop joint is satisfactory in every way.

S. C. Bowers:—We have 60 rigid standpipes on the Pitt burgh division, and we have no order for the engines to cut o from their trains, but the tenders have an opening of about in. If the engines stop within five feet it is all right. We dor have a bit of trouble. We have never had any experience wi the telescopic spouts.

ORGANIZATION AND OPERATION OF BRIDGE AND BUILDING MATERIAL YARDS

By H. C. Pearce
General Purchasing Agent, Seaboard Air Line

I deeply appreciate the invitation of your executive committee to address you on one of the subjects which have brought you here for discussion and consideration. In presenting my views on this subject, I have taken the position that you are here for the purpose of discussing and determining the best methods of organizing and delivering the material which you require to do your work.

The question of what department should organize and operate our bridge and building material yards is of much less importance than that they should be properly organized and supervised. There appears to be no good reason why the supply department should not purchase and distribute lumber the same as other materials, and there are many sound reasons why they should.

The location of our bridge and building material yards must be of first consideration, and this must be governed very largely by the geographical location of the property. In the southeast, it has been an open question in the past whether it was either economical or necessary to have large general distributing bridge and building yards. Most of the larger systems in the southeast have a large number of mill operations on their own lines, particularly in Georgia and Florida, and lumber has been cheap. Under these conditions, arrangements can be made with certain mills to take care of certain territories, and by carrying out the budget plan of work and by close supervision and inspection, bridge and building lumber can be moved promptly to the structures where it is to be used and save the cost of operating a general distributing yard and back hauls. This plan, however, leaves many loose ends, and incurs many concealed losses, and is not, and never will be, entirely satisfactory, but the direct saving is so considerable that it must be considered under certain conditions.

On the Pacific Coast, a large portion of the lumber comes by water. This makes it desirable that the material yards be located sufficiently close to the docks and wharves to use switching service. Lumber can be taken from the ships, inspected, segregated and loaded on cars directly from ships' tackle, by placing carriers between sling loads, and can be switched to the yard and unloaded by cranes direct to the piles with practically no more expense than what it ordinarily costs to unload and pile from cars in the yards. In the middle west, the location of lumber yards will depend largely on the location of the timber treating plants and the distributing territory, so that, broadly speaking, the location of the lumber yard must be left entirely to the geographical location of the property, taking into consideration the source of supply and the location of the timber treating plants.

Laying Out of Yards

In laying out bridge and building material yards, the first consideration must be sufficient space and trackage. I have found double tracks to be the most economical. They require less space and ensure a more concentrated organization, switching facilities, and the use

of cranes. Where sufficient water is available, an excellent plan boom the piling. Piling can be sorted and classified in this way conveniently, and taken directly from the water to the carriages o torts, or loaded directly on the cars. This plan offers many advant

Piling, stringers, and other trestle timbers should be unloade tracks adjacent to each other so that a train of cars can be set in as many feet of trestle timber as required, loaded in the quickest sible time. Cranes should, of course, be used wherever obtainab handling heavy timbers and piling. I have found steam locom cranes to be the most useful for all general service, because they the place of a yard switching engine, although I can fully appre that there are many places where gantry cranes can be used more nomically and expeditiously. However for all general purpos steam locomotive crane will be found most practical.

The ideal bridge and building material yard would include a ber treating plant, a planing and wood-working mill, an assembling a rail yard, a frog and switch shop, and a general store, for the re that it is desired wherever possible to load everything out comple one shipment or shipments from a central distributing point. A ciating that in only very few cases would it be possible to hav ideal location and the facilities referred to in one place, we will tak position that it is necessary that a bridge and building material should include the tie and timber treating plant, a well equipped w working and planing mill, a material platform and a storehouse typical layout is submitted herewith.

Typical Material Yard

The ideal bridge and building material yard should be so arra that all the material, from the piling to the bolts and washers, wi loaded and shipped in the same train. Frequently a certain numb feet of track, as well as a certain number of feet of trestle, is requ The organization should be such that the necessary rails, fasten frogs, switches, etc., can be loaded and shipped along in the same ner.

Organization

Maintenance officers have criticised our supply departments for ure to provide material in an intelligent and prompt manner, and properly so. The reasons are many, but the principal one is tha supply officers do not understand the importance of assembling materials so they can be shipped in the order they are needed.

I have heard the statement made frequently, and no doubt it is that about the first thing to reach a structure is . . . the roof. Thi course, is absurd, and has greatly discredited the generally excelle organized and efficient work of our supply officers.

The maintenance officer, having prepared his plans and rece authority to do certain work, then concentrates his efforts toward ting it done. Under a proper organization, he should immediately pare his requisitions for the necessary material to do the work, des

ing and classifying them properly. By that, I mean, consolidating the foundation material, superstructure, mill-work, hardware, etc. These requisitions, when properly approved, are forwarded, with all the necessary data such as blueprints, and sketches, when necessary, to the storekeeper, who arranges immediately to assemble all the material for this work. For this purpose, he should have sufficient storehouse and platform facilities for assembling such portions of the material required as must be assembled and held together. Foundation material must, of course, be ordered first. This, in most cases, will go direct. Mill-work must be ordered, or manufactured in the mill. Hardware must be assembled, boxed and marked. The lumber requirements must be checked up carefully and any item short provided.

Unless the requisition states specifically that certain portions of the material for the structure is to go forward, nothing should be shipped until everything is ready. The storekeeper will then notify the officer in charge of the work that the material is ready for shipment and will go forward on a certain date,—later advising him the car numbers and date forwarded, and sending him a detail memorandum invoice covering the shipment. All of the material should be charged direct to the job when shipped. When the work is completed, whatever is left over should be picked up, shipped back, and proper credit allowed to the work order.

It may be said that this is an ideal only, but this plan has been in effect on the Southern Pacific Company's Pacific System for ten years, and no doubt it is in use on many other railway systems.

Personnel

The personnel necessary to handle an efficiently organized bridge and building material yard may be said to consist of a foreman in direct charge, with as many working foremen as may be necessary, divided into gangs of about five men each.

It may be said that the foreman should be a practical bridge and building man, and this would appear to be a reasonable conclusion, but the best material yard foremen that I have ever developed were from clerks. I have never been fortunate enough to have developed a first class, all around, capable material yard foreman from a practical bridge man. I appreciate perfectly the need of having practical men who understand the use of material, but these will be found among the inspectors and sub-foremen. What is needed for the operation of a general material yard is a man who is primarily a systematic organizer; a man who is always studying to do things a little better and a little cheaper than before; a man who is not only interested in the material which he is handling but in the systematic working of the organization.

This leads me up to the question as to what department should maintain and operate our bridge and building material yards. I have stated that I know of no sound reason why this work should not be handled by the supply department. My reasons are that the providing, distributing and accounting for materials has become a highly specialized service. It is now generally recognized that the work of buying, providing and distributing materials should not be divided, and that the supply department shou'd have charge of and be responsible for all unapplied materials. Such a department must be properly organized and have a sufficient well trained force to do the work in the most expeditious and economical manner. The handling of bridge and building material offers no more complications than the handling of the other supplies on a railroad, and, in many ways, not as much. The same general organization is required, and the same general procedure must be gone through, both as regards buying, shipping and accounting, as well as the responsibility for supply.

It will be said that the storekeeper or purchasing agent doe
know what is wanted, that he does not buy or provide the right
In many cases this is true, but the conclusion is based on the w
assumption. It is the duty of our technical officers to prepare the
ifications and make the inspections. Our maintenance and tech
officers should be required to incorporate all of their experience and
nical knowledge in the specifications, and the inspectors should b
quired to follow these specifications.

The supply department is the providing department. It is the
of supply officers to so systematize their organizations that they
know absolutely before a purchase is made that it is necessary;
the proper materials have been specified; that the requisitions are
pared in such a manner as to procure the broadest competition;
arrange their materials when received and to so organize their
that they can be inventoried accurately, loaded, shipped and deli
where they are required in the shortest possible time, and to see
the salvage is returned, sorted, classified, reclaimed and disposed
the best advantage, or, in other words, it is the duty of the suppl
partment to follow the material from the time it is ordered unt
salvage is disposed of. Unless the supply department is organized
on the basis of giving proper and immediate service, it can never be
nomical or efficient, and can never hope to accomplish the real pu
for which it was organized, which is the providing of suitable
rials when and where they are wanted, at the time they are wanted
at the lowest net cost.

For these reasons, I reiterate that there is no sound reason
our supply departments should not organize and operate our
and building material yards in coöperation with our maintenance
cers.

I am not unmindful of the fact that this is a very important qu
to you gentlemen, and that many of you have neither the facilitie
organization at your command to carry out the work as I have
lined, but I am sure you will agree with me that we must have an
to work to in every effort, and that our first purpose in every w
life is to first establish the ideal and then work as near to it as w
When you gentlemen have a structure to erect, you first prepare
and specifications. Conditions may arise where it is necessary to c
your plans and specifications, but your first plans always form the
of the future. The same thing applies to the establishing of an o
ization. You must first understand the fundamental principles go
ing the condition which you are organizing to meet. You then la
your organization. The plan must be big enough to meet all
tions. Then it must be curtailed to meet your own peculiar cond
without destroying it. This has been the primary trouble with th
ply departments on our railways. They were started on a small
and added to. They should have been started in a broad way an
tailed when necessity requires, or broadened out to meet changing
ditions. So, if you gentlemen will take hold of this situation v
broad prospectus of the ideal plan and coöperate with your supp
partment in assisting it to obtain the facilities and organization to
work as it should be done, you will procure the results which
are aiming at and at the same time leave its operation in the ha
men who are trained to do this work and not burden yourselves o
organization with work for which they are not trained or directly
ested in.

Supply officers must get away from the idea that their unit of
ure is the cost per dollar for material issued. They must get away
the idea that the saving of cents will overcome the loss of dollars.
must get away from the idea that their payroll is the measure of
efficiency. They must get away from the idea that constructive
icism should be resented. They must take on a full understandi

what their duties are. They must appreciate the men who have big work to do under most adverse conditions. They must understand that the engineer at a washout or wreck wants material then. They must understand that a man who has a certain structure to build within a limited time and with a limited amount of money, must so organize his forces and do his work as not to be delayed. They must realize the need of action, and then act. They must encourage, receive and accept criticism. They must take on the full responsibilities of their position and make themselves a real constructive instead of destructive force. All departments must coördinate and coöperate with the single purpose of the best interests of all, and, in doing this, it will be found that the best coöperation is where each department and each individual does his whole duty, and when this is done it will be found that the very results desired are obtained, and with the greatest satisfaction to all.

DISCUSSION

The President:—It has been my experience that it does not matter very much whether the bridge and building material yards are under the supervision of the supply department or the bridge and building department, provided you have the right measure of coöperation. Once in a while the superior officers have got to pull the conflicting interests together and impress it upon them that both must live. I know that on the Missouri Pacific they had every conceivable organization you could think of, but when I finally got hold of the engineering department I found it didn't take very long, by coöperating with the general superintendents, to get everything we wanted, when we wanted it, and all we wanted of it.

J. P. Wood:—It has been my experience with my stores department—and I believe it is the experience of the average bridge supervisor—that you have trouble in getting your supplies when they are handled strictly by the stores department. We have what perhaps is a good organization on our road in the stores department, and they would like to take our stock over. They did try it but they made a failure of it and we are still handling it. You can place your order with them for building stock (we don't handle our own building stock) just as is outlined in Mr. Pearce's paper, you get the whole plan laid out, get your foundation drawn up and your order placed, and what is the result?—you get the roof materials about the first thing. I have had this happen at a freight house during the past year. One piece would come down in one carload, and another piece in another carload, some of the hardware at one time and some more at another time; they have been using that freight house

for the last six months and some of the hardware isn't there ye
That hardware was all ordered on one requisition.

When a storekeeper will say "I reduced my material ac
count $33,000 last month, and I tell you that looked good t
me," it is not absolute coöperation on their part. It did no
make any difference to that man how much he delayed you o
work; maybe you had to move the men a hundred miles t
some other job,—it didn't matter to him as long as he could cu
his material account $33,000 in a month and make it look goo
He is working for his end of the game.

J. S. Huntoon:—I most heartily concur with Mr. Wood. W
have an organization just like that. The purchasing agent ge
the material and the general storekeeper sends it out. About th
middle of the summer we make our regular inspection. W
come in and prepare requisitions. They are marked "wante
April 1st," about nine months later. A year ago when w
wanted the material there was no more in the storehouse to d
the work with. The bridge gang payroll was running int
thousands of dollars a month; we didn't have any materials fo
three months, and probably the money expended in sending th
men around from one job to another was more than the pu
chasing agent would have had to pay to get the material to u
on proper delivery.

B. F. Pickering:—I think that only one side of this questio
has come to the attention of the responsible officials. The sto
department repeatedly shows how much it has reduced its stoc
That is the great item, and the great excuse, if I may use th
word, for the storekeeper's existence, but against that they don
show, and there is no way of showing, and the responsible o
ficial never knows, the great cost of the delay caused by the lac
of material being delivered to the various working forces o
over the road. They only see one side of the ledger, and th
storekeeper is very careful to see that the responsible offici
only sees his side of the facts. He never knows anything abou
the delays and the great cost occasioned by failure to receiv
materials. Consequently, he is immensely in favor of the store
department. If an accurate account could be kept of the cost o
delays for want of material on the various jobs, one would fin
that the savings of the stores department would not only b
wiped out, but the loss would be seven or eight times all the
had saved.

The President:—I got up to say almost exactly what Mr. Pickering has said. It is again a case for the education of the railroad officials, and they need this education to find out what is going on. There is now a well defined method by which they receive statements showing the accounts of the supply department. They ought also to have a report showing in detail the work done on the road and the delays occasioned on the road for want of the material. Then those two taken side by side would enable them to see wherein the supply department was inefficient. It is going to take a long campaign. It is one that can not be fought by the bridge and building men alone. It is a case of gradually pushing against the higher officials.

I have had my hardest fight with the general purchasing agent. He and I were cross-ways most of the time on getting the materials out. I made it a point to keep in touch with the reports in his office of what he had in his material yards, and whenever they were getting down I was right in his office reading the riot act to him to see that material was not delayed.

THE ORGANIZATION AND OPERATION OF A BRIDGE AND BUILDING SUPPLY YARD

By Geo. T. Richards, Superintendent Bridge and Building Shop
C. M. & St. P. Ry., Tomah, Wis.

A bridge and building supply yard is not, as a rule, an institution which has been planned, organized and placed in operation within a brief period of a few weeks or months, but, with few exceptions, it is the result of the gradual development of a comparatively small unit consisting possibly of a small force at a transfer or junction point, a storage yard for a division, or, like the yards and shops of the Chicago, Milwaukee & St. Paul at Tomah, Wisconsin, of a yard for storing and distributing piling and timber. As a result, the additions in the nature of tracks, buildings, etc., are not always located to the best advantage. Additional land is not always available where most desired, and it is necessary at times to locate a building, or to store material, where it is far from being as convenient as it would have been had the plant been planned in its entirety at the outset.

One of the first points to consider in establishing a supply yard complete with wood-working shops, concrete pipe, bridge slab, and pile plants, and other departments which assist in the manufacture of materials used in the bridge and building department, is its location as a receiving and distributing center for the territory to be supplied. It should be situated at a point where piles, timber, lumber, hardware and other building material can be obtained readily and assembled in large quantities, either for storage or for diversion in part or car-load lots to other points for emergencies.

When the C. M. & St. P. located its supply yard at Tomah, Wisconsin, some 30 years ago, the site was evidently selected because of its central location, prior to the construction of the lines west of the Missouri river, and also because it was the terminus of the Wisconsin Valley division which at that time was opening up vast tracts of Norway pine, tamarack and hemlock timber in central Wisconsin. It was also well situated for the reception and storage of the other materials used so extensively in this department.

The plant at Tomah consists of a wood-working shop with a shop foreman in charge of a force of machinists, carpenters, painters, a gang foreman and laborers; a storage yard in charge of a yard foreman, an assistant foreman, crane engineers, mechanics, gang foremen, laborers and teamsters; and a reinforced concrete materials plant with a foreman, an engineer, finishers and laborers. Each of these departments has its special work and duties, and at the same time is so planned that there is the fullest co-operation.

The carpenter or wood-working shop is a large building 65 ft. by 350 ft. divided about equally into two parts known as the front and back shops. The front shop is steam heated and in it are installed various wood-working machines and carpenters' benches. Near the entrance is an enclosure providing an office for the shop foreman where he can readily take care of his records, plans and orders. At the rear and on the side nearest the yard is a space reserved for work-benches, accommodating from 8 to 12 carpenters. The machinery in the front shop consists of moulders, matchers, planers, jointers, a sander, rip, band

and cut-off saws, tenoning, mortising, boring and pipe cutting and threa ing machines, a turning lathe, a giant dimension planer and saw and kni grinders. The several rip and cut-off saws are so distributed as to ca for the least possible carrying of material about the shop. A machi for cutting the gain in ties is now being installed. The method use heretofore was to run the ties through the surfacer, and then to the cu off saw, after which they were carried to a place where the gaining w done by hand with saw and chisel. Then they were loaded on ca thereby consuming much time and requiring a lot of handling. With t new machine in service, the ties will be taken from the surfacer to t gaining machine where the gain and cut-off is accomplished in o operation, and then loaded on cars. This machine will save the cost its installation in a comparatively short time. The machines in the fro shop are so arranged that the material is handled through the mill w a minimum amount of labor and time. The first class carpenters a machinists in this portion of the shop are engaged in the manufacture all kinds of mouldings, interior trim, frames, lunch counters, locke station settees, office partitions, forms for various kinds of concrete wo etc. The machines most commonly used are near the front end of t shop with large sliding doors on both sides, thus permitting the lumb to be unloaded from cars at one side of the shop, and reloaded on ca on the other side after passing through the machines.

The back shop occupies the rear half of the building. This is w lighted but is not heated. A standard gauge track runs through its cent and connects with other tracks at the far end of the yard. The work second class carpenters is performed in this part of the shop, assist at times by first class handy men, and consists of water tanks, towe sign posts, roundhouse doors, portable buildings, cattle guards and win and similar work. Howe truss spans are also framed and erected in t part of the building. On the side of the back shop nearest the yard i saw mill for resawing timber and piling, which is found very useful working up surplus and second hand timber.

Adjacent to the shop and located conveniently are a lumber shed f housing finishing lumber, ceiling, flooring, etc.; a shed for storing mou ings, casings and mill finish; a dry kiln; a storeroom for miscellaneo tools, hardware, and small building material; a paint shop; and a cre soting vat for treating ties and guard rail. The shop is under t immediate supervision of the shop foreman, who assigns the work as t orders are passed to him, and who is directly responsible for the finish work.

The storage yard is adjacent to the wood-working shop, and is l out with a view to minimizing the cost of handling material. It is locat on both sides of a main thoroughfare, and near the railway station a the railway yards. Six tracks extend for its entire length, with o track on each side of the shop. A third track is located on the side the shop adjacent to the lumber shed and the other buildings mention above, permitting material to be handled to and from those buildin without interfering with the work in the shop. The three other trac are on the opposite side of the shop and constitute the yard tracks. Th are located at intervals which allow for loading and unloading t material by locomotive cranes, of which two are in use. The mater which must necessarily go through the shop is placed where it can taken to the shop conveniently and to the machines, while other timb used mostly in the rough, and piling are stored in the extreme end the yard, the piling being kept by itself, and farthest from the sh and other buildings In storing material it is aimed to pile it in such way that the oldest or that longest in stock will be used or shipped o first. The storage yard is under the supervision of the yard foreman, w is held responsible for the prompt handling of cars and the loading a unloading of material. In addition to having executive ability, the ya foreman must have a wide experience and a knowledge of the materi tools and machines which he is called upon to take care of.

The yard force varies from four to six crews of from 8 to 12 men each, according to the amount of work on hand. Two locomotive cranes are in use, and it has been found that they have greatly reduced the cost of handling heavy material through the yard. Experience shows that a gang foreman, a crane engineer and 4 laborers will operate a locomotive crane to good advantage and do as much work in the same length of time as two crews of 12 men each without a crane. The crane is also used for switching purposes, and is especially useful in moving cars back and forth when unloading or loading timber of various dimensions, and piling of various lengths.

A light draying outfit is kept busy hauling material about the plant and small items of hardware and building material to the station for shipment by way freight or baggage. By careful planning, the use of the draying outfit saves much car handling in the yard, and very few cars go out without maximum loads.

A space is reserved for the manufacture of reinforced concrete materials where it will not interfere with other operations of the yard. It is located between two tracks, one of which is used for the unloading of raw materials such as cement, sand, stone and reinforcing bars, and for loading out cement pipe, and the other for storing manufactured material and later for loading it out. Raw materials are so unloaded that they are readily conveyed to the mixers and forms. The chief output of this part of the yard is concrete culvert pipe, but the same force is used to turn out deck and trestle slabs, piles, water troughs, platform curbing, right of way monuments, flue and manhole caps and unit foundations for buildings.

The platform and mixer for the manufacture of all items except pipe occupy the rear end of the space provided; the pipe circle is next, and the storage yard for pipe, which requires considerable space, is in the foreground. An electric hoist within the circle removes and places the steel forms, and removes the pipe from the circle when it is dried sufficiently. A similar hoist at the entrance to the plant loads the pipe for shipment when cured. When the pipe is taken from the circle, it is rolled toward the loading hoist on skids, thus placing the oldest pipe nearest the point of loading. When the storage space for pipe is limited, they may be decked by placing skids over the lower tier. A shelter shed provides a place for assembling cages for pipe and slab reinforcement.

While the plant does not operate throughout the entire year, it runs well into December at times, and may resume work as early as February. In this locality a heating system is necessary for drying pipe during the late fall and early spring months. During the severe winter months the output is so small that the cost of production is too great to warrant its operation. The foreman in charge must exercise great care in the manufacture of concrete products, to see that the sand and stone are clean and of good quality, and that the stone is of proper size. Thorough mixing, filling, and tamping and proper finishing will insure good pipe, and may result in a season's run without a single rejection.

The crew operating this plant consists of a foreman and from 15 to 20 laborers. The records of time, distribution of labor, etc., are handled by the foreman in charge.

The following instructions for handling requisitions, sub-orders and shipping notices are being followed with very satisfactory results:

Requisitions

Requisitions on Tomah yard and shop are made in duplicate. When received, they are stamped with a dating stamp and the originals held in the superintendent's office. If the requisition is for fabricated work to be made in the shop, the carbon copy is sent to the shop foreman and a notation is made to that effect on the original, after which it is placed in the unfilled order file.

If the requisition is for material to be furnished from stock, a sub-

order (as directed below) is issued on the yard foreman and the requisition with proper notations is placed in the unfilled order file.

There is an unfilled order file for each division in which the unfilled orders are arranged numerically and held until the material ordered has been shipped. The unfilled order files are examined daily and studied carefully with a view to seeing that shipments are not being delayed or overlooked and also to plan for the maximum loading of cars.

Orders on the Shop Foreman

The shop foreman, upon receipt of the carbon copy of the requisition, arranges at once for the manufacture of the articles called for and keeps the superintendent advised as to the progress and probable date of shipment in order that shipment with other material may be planned for. When shipment is made, he will note the car number and date on the requisition, sign his name and return it to the superintendent's office where the shipping notice is made.

Sub-Orders on the Yard Foreman

When material is to be furnished from store, a sub-order (Form Engr. 180) is made in duplicate, both copies are handed to the yard foreman and the original requisition with proper notation is placed in the unfilled order file.

The yard foreman places the original sub-order with a gang foreman and retains the duplicate in a special file enabling him at all times to know what orders are unfilled. The gang foreman carries the sub-orders in a metal binding clip of a size that will easily slip into his pocket. Gang foremen are required to deliver their clips containing unfilled orders to the yard foreman before leaving for home each evening.

As soon as the material is loaded the gang foreman fills out the information called for under the heading "shipment made," signs his name and hands the sub-order to the yard foreman.

The yard foreman makes a notation on the duplicate sub-order, places it in his "filled order" file and delivers the original to the superintendent's office where shipping notice is made.

If a sub-order cannot be filled completely in one shipment, it is turned in to the superintendent's office each time a shipment is made in order that shipping notice can be issued.

Shipping Notices

Shipping notices (Form 229) are to be made out in the superintendent's office and mailed on the same date that shipment is made.

The original shipping notice is mailed to the consignee, a carbon copy to the chief engineer, and other carbon copies are sent as requested on the requisition.

Filled Orders

When the requisition has been filled and the shipping notice made out and mailed, the sub-order is pasted to the original requisition and they are pasted in a scrap book as a record for making bills.

Time Returns

Gang foremen keep a record of the time worked by the men under them on a card (Form Engr. 359). On this card is entered the man's number, name and number of hours worked each day. The card is turned in at the office each evening and called for again the next morning by the gang foreman. In the office the time worked by each man is entered in a time book each evening.

The gang foreman also makes a labor distribution for his crew for each day on form Engr. 358 which is also delivered at the office each evening with the time card.

Form 225

Chicago, Milwaukee & St. Paul Railway Company

____________________ ____________________191___

____

I have this day shipped to____________________at____________________

from____________________in________________, ________________the following:

ORDER NO	ARTICLES

SIZE of SHEET $8\frac{1}{2} \times 5\frac{1}{2}$

No.__________

If above material is not received promptly and in good condition, please return notice to Consignor so advising. If MATERIAL IS O. K. DO NOT RETURN.

____
CONSIGNOR

Engr. [illegible]

Chicago, Milwaukee & St. Paul Ry. Co.

ENGINEERING DEPT.

........................Supply Yard.

NOTE—The Foreman will enter on this sheet the total number of hours worked by all of the men in his crew on each piece of work. For instance, if 5 men spend 6 hours each loading a car of bridge timber the amount to enter on this sheet is 30 hours.

FOREMAN'S DAILY TIME DISTRIBUTION SHEET

The following is a correct distribution of time for

Crew No.............Date.................................191....

....
Foreman.

Req'n	DESCRIPTION OF WORK	Hours
	Total	

SIZE of SHEET 5½x8½

0-4-17 5M Form Eng. 180

SUB-ORDER

Tomah, Wis.,..191.....

PLACED WITH

..............................*Gang Foreman*......................................191......

SIZE of SHEET
8½×4½

Ship to C., M. & St. Paul R'y Co., care of

....

Station..

Division..

Req'n....................*Date*....................191....

for..

....

Ship..191....

SHIPMENT MADE

In....................*Car*..

....

Way-Bill..

Date..191....

....

Gang Foreman.

Engr. 359

C. M. & ST. PAUL RY. CO.—ENGINEERING DEPT.

Foreman's Weekly Time Card

....Supply Yard   Crew No.....................

Number of Hours Worked Each Day		Month							191 ..
No.	NAME	Day							
	Total Hours Worked Each Day								

SIZE of CARD 4½ x 5½

I certify that the time entered on this card is correct.

....Foreman.

SHIPPING COMPANY MATERIALS ECONOMICALLY

By J. R. Pickering

Superintendent of Car Service; Chicago, Rock Island & Pacific, Chicago

Car conservation is the most prominent factor facing not only the railroads, but the country as a whole today. The railroads are maintaining a large organization at Washington as well as local organizations at all of the principal railroad centers in the country with a view of increasing car efficiency by securing maximum loading, prompt loading and unloading and the expeditious handling of equipment in general.

Much has been said to the public as to their duty in loading cars to the full carrying capacity and loading and unloading cars promptly, until today there is not an industrial concern or individual shipper in the entire United States who has not had this drilled into him thoroughly. In their zeal to impress upon the shipper the importance of car conservation, the railroads individually and through the various railroad organizations have, in a great many instances overlooked their own short-comings, namely, "What will the railroads do to load cars to full carrying capacity and to load and unload them promptly?" I am sorry to say that a great many railroads are deficient in this practice, although there has been a pronounced improvement.

A great many railroad officers and employees feel that in view of the fact that they own or control the equipment they can do as they please with it. This is a mistaken idea. It is the duty of the railroads to practice what they preach. It is just as much of a crime for a railroad to permit the light loading of a car with company material or to permit delay in its loading or unloading as it is for a shipper to detain the car or unload it. The only difference is that the shipper pays for his negligence by reason of demurrage, etc., while the railroads have the mistaken idea that they are not penalized. Such is not the case. They seem to overlook the fact that a car under load or a car unnecessarily delayed in loading or unloading means the waste of car days and an ultimate loss in valuable freight revenue. Too often it is easy to pursue the line of least resistance and load a few hundred pounds of scrap, a pair of wheels, an odd hand car, etc., into a convenient car, simply because the local employe wishes to get the material off his hands. Proper supervision will overcome this. How much easier it would be to establish a regular schedule for shipping scrap to the store department, holding the wheels until a full carload has accumulated (except of course in extreme emergencies), sending the hand car and other miscellaneous supplies to the local freight station where they could be put into a regular merchandise car. These are the practices that must be put into effect if the railroads wish to meet the emergency, do their bit toward conserving supply and secure the coöperation of the public. In ordering supplies, the purchasing departments should order them in full carload lots and buy accordingly, insisting on the industry from which they purchase these supplies loading the cars to the full carrying capacity. This can easily be regulated through the purchasing department and is now being done on a great many railroads. Superintendents, storekeepers, master carpenters, master mechanics, bridge foremen, etc., should anticipate the arrival of material and be prepared to unload cars promptly upon their arrival, adjusting themselves to meet

this condition by arranging with the superintendent to have the y
master or agent wire them when the car leaves the terminal poin
station billed to them. This can easily be arranged for and is b
done on a great many railroads.

The loading of cars can be handled in a like manner. Empty e
ment should not be ordered for loading material until the load is act
ready for the car and then all the forces available should be put or
loading until it is completed. This may delay some other work te
rarily, but how much better it will be to get this loading out of the
and send the car on its way so that it can be released promptly and
to earning further revenue for the company.

A daily check of the number of cars of company material on h
the commodity and to whom consigned should be kept by every su
intendent. The general office should have a periodical report we
or monthly showing the number of cars company material handled
each department, the average delay to cars in transit, the average d
to the cars unloading and the average delay to the cars on hand t
unloaded. It is surprising the results that can be obtained by ina
rating a system of this kind and it is the only way to follow up this
important matter intelligently.

The most important thing to remember however, is that the
roads cannot expect the public to conserve the car supply of the na
and secure their fullest co-operation without first showing the p
that they take the lead in matters of this kind.

DISCUSSION

The President:—The paper on shipping company mate
is now open for discussion. I hope you members will
cuss it actively, because it is a very important subject.
importance to the railroads of loading their cars to capacit
indicated by the report of the movements during 1916, w
shows that, notwithstanding the various increases in fre
rates which we have heard so much about in the newspap
the freight was transported in 1916 at a lower cost per ton
mile than anywhere else in the world. Cars which were
merly loaded with 10 or 15 tons now have to be loaded
35 or 40 tons in order that the companies may get the ser
out of the cars.

E. T. Howson:—Simply to start the discussion, I wan
say that I was in the office of the operating vice presiden
a large railroad not long ago (he being in charge of opera
on a railroad which has been very successful in increasing
average carload of traffic) and he said that when he go
checking up the figures the surprising thing to him was
the improvement had been almost exclusively in the handlin
revenue freight. There had been little or no response in
handling of company material. He immediately started a c

paign among his own employees. He said that the only explanation he had was that the employees figured it didn't cost them anything to haul their freight, since they were company cars.

L. Jutton:—I think we ought to do a good deal of educational work in our own departments among our own men in connection with the economical handling of cars and loading and unloading them. I believe there are many foremen who don't appreciate the necessity of unloading cars quickly. They think, "Oh, well, I can't get at that to-day, I have got to do some other work." It may be economical for him to do the other work and let that car stand over, but the company does not see it that way; someone outside of the department hears of it and then there is trouble. I think if we will be fair with our own department about releasing cars and about loading them, we will be free from criticism from the other departments, and when we do have a real cause for holding a car, we will be listened to and we will get off a great deal better, and not be criticised as much as we will if we are constantly guilty of holding cars without being able to give a good reason.

The same applies to loading out material from the material yards. If we are careful in the use of our cars and load them to the fullest capacity possible, then we will be able to put up a strong argument in requesting cars, and there will be nobody who can say to us, "Well, you don't deserve a car to-day, because you use them wastefully." I believe that much can be accomplished by educating the men in our own department.

J. P. Wood:—Along this line I may say that our road has put on a new car service man to take care of the cars and to find out why they are not unloaded. He is checking them carefully, day by day, to know why these cars are not being unloaded promptly, and if they are not we hear of it.

Now it has always been my practice to beat the other fellow at his own game if I can, and I have succeeded very well with the car service man. I have placed the responsibility on the foremen that when they receive a notice that a car is coming, they are to be on the lookout for it and not let it get away from them, but to unload it immediately upon arrival. I have also instructed them when they ask to have a car placed for unloading, to take it up with the yard master or the agent, so if there is a come-back they will have something to show. We have been very successful up to date in not having them get

anything on us, simply by being vigilant and constantly on t
job. I think the average supervisor will find he has to be co
stantly on the watch-out for these cars, and if he is, he can do
great deal to relieve the situation, and release these cars f
other purposes. And not only that, but, as Mr. Jutton say
it will help him out when he wants to get a car.

J. B. Sheldon:—We have had this matter very forcibly i
pressed upon our line. Something like a year ago we inaugu
ated a system on my division whereby each foreman was su
plied with a blank form on which he reports every day eve
car he loads, every car he releases, and every car he has und
load and its destination. We make a daily report to the super
tendent of the same kind. All foremen have instructions th
the loading and releasing of cars takes precedence over all oth
work.

W. E. Alexander:—A great deal might be said on this su
ject. The circumstances in each case are different. Now we a
that a car be set at a certain point. We want some material o
on the road, perhaps it is five or six thousand feet of plank
some repair work on a branch line. As soon as the car is
we load the material, and there is no other material to put
that car. We need the material at once. The men are in th
vicinity and they want it for their work. The material is load
and sent out. It is unloaded promptly and the car goes on to
ceive another load. Now, suppose we had held that car a
loaded a part of a load on it for one place and a part for anoth
place, detaining that car until the men are out of that vicini
When the car gets there how are we going to unload it? W
will simply have to send men to do it. And if the car is load
full there is more detention than ever. We send cars out, load
with small amounts to get it to the men quickly, when they wa
it. Now I am heartily in coöperation with the handling of m
terial in the best possible method known, but the local co
ditions govern that. I am impressed with the importance
fully loading the car. But we simply can't do it and keep
the maintenance work and have the cars unloaded promptly.
agree with the idea of conserving the use of the cars, but wh
a car arrives at a small country station, if the agent is not care
to report it, there is no way for the bridge superintendent
know that the car is there until he finds out himself perhaps,
accident, because traffic is so congested that the car is set an

where in some out of the way place. Then you get a complaint from the car distributor that that car arrived at a certain place on such and such a day and was not unloaded.

F. E. Weise:—It is necessary to have the full coöperation between the various departments. If a report comes in from the car service superintendent the mistake has already occurred and you can not do anything to prevent it. The effort must come from the men, and the man in the supply yard probably has the worst end of it, because practically all his orders are marked "Rush." He is up against it. Here is an order for material which may not weigh more than 10,000 pounds, going to one division. He has nothing else going that way and probably won't have for a week, and he does not know what to do. In ordering the materials, the man on the work should order it as far in advance as possible, and then there should be some leeway allowed to the man in the supply yard in shipping the materials.

Z. T. Brantner:—I have had quite an experience along these lines. We receive perhaps 200 cars a month for unloading and we load out about 150 cars. In receiving the cars we have a sidetrack on which the cars are placed by the yard master. The time is taken when the car is placed on the track and it is also taken when the car is released. We make an effort to release those cars just as quickly as possible. For instance, if we receive a span of girders, I have arranged special small trucks, on which the girders are jacked up and taken off, taking about four to five hours. I aim to load open cars to full capacity if possible, and if one division does not require all the car will retain, the first division will receive its load on top, and the following division the one underneath, etc. In this way we handle the loading very successfully, and we rarely have cars on hand more than 24 hours.

P. J. O'Neill:—I presume I have as little trouble as any one, for the reason that I have a number of department cars that are used entirely on our work in which I load a lot of small shipments and send them out. The repair gang takes the car along with it. In that way I can send a carload of material out from the yard and when it is all unloaded the car comes back and I load it again and send it out. Every day I have a report from all of my foremen telling what cars they have on the track and what they have released. Every Saturday I compile a re-

port and send to the superintendent for his use at a meetin the superintendents of the Toledo territory, which is held ev month. Since we have been doing that I think we are get the cars released more quickly. Of course a man will occas ally do something else before he unloads the car, and there still a good many complaints regarding the detention of cars, they are being eliminated.

I formerly sent small shipments by local freight, but so how or other, while the agent would unload everybody el material, he would perhaps hold that car and notify me th was detaining it.

The President:—The best method I ever experienced getting cars out on the line was when I was with Mr. Reid. repair program was made out on typewritten sheets, and o was a bill of material for each bridge. The programs were not only to the foreman assigned to the line, but to the st keeper from whom he was to get his material. The storeke would keep in touch with the foreman, and when he was vised the storekeeper would load up a full carload of mate and send it to the foreman, who would have someone unloa at certain points where they wanted it. Occasionally a wh carload would be shipped to a certain point, if it was on a job.

R. H. Reid:—When working orders are made out for a tain branch or division, they cover the entire season's work that division; the bill of material for each job is made ou the same time and sent to the storekeeper, with a copy to foreman on the job, a copy to the general foreman of the vision, and a copy retained for the office accountant, so t each one knows what material is to be used for each job. material is shipped when we call for it, and it is so loaded t when we start from one end of the division the material wan first can be unloaded first from the car, and so on On st jobs we can frequently take one car clear through, doing work on two or three jobs in one day, then moving along another station and taking two or three more jobs. If the is big enough to take several days, we unload all the mate for it and then go along with the work. That minimizes car tention and also reduces the cost of handling the material.

Our requisitions are made up with a copy for each int ested party, but sometimes material is shipped from the m

chant or manufacturer without any notice to anyone. Occasionally the first we hear of it is a message from the car accountant that car so and so has been at such a station perhaps a week, and wanting to know when we are going to unload it. Then of course we get busy immediately and unload it, but the delay there is caused by the failure of the manufacturer to notify our people of the shipment of the material. We are watching the car situation very closely. Everybody from the president down is after us. Of course I keep after the general foremen and they keep after the division foremen. Hardly a week goes by but we send them a circular letter calling attention to the prompt release of cars. We have had very little delay where we have known of the shipment.

A. S. Markley:—How do you distribute the timber?

R. H. Reid:—Ordinarily by local freight. We use very few work trains. I have not ordered a work train this year for distributing material. In former years we did use work trains in some places where we would have a heavy load, and where the regular service was infrequent, but the regular service is better now, and better adapted to our needs, and our people are much more stringent in the matter of furnishing a work train, especially on Sunday. Since the war is on it is almost impossible to get a work train, and unless there is a very good reason for it, we have been told pretty positively not to order one. Work is either done with the regular equipment, or, in some cases, with the help of the road master's work train. Where they have a train they are generally very accommodating and will allow us the use of it.

A. S. Markley:—Then the timber is scattered all along the route, and when the section men come to it they have to pile it up, because if it lies on the ground it will spoil; you would in some cases have those men working all night.

R. H. Reid:—We very seldom find it necessary to keep the men out over night. They go through on the local train, unload the material at or near the jobs, and pile it up in as good shape as they can to protect it, but we do not keep them working on that until they are unable to get back to the boarding cars at night. If we find it necessary to have men out over night, we select those who live at a point near the work who can go home during the evening, so as not to cause extra expense for them.

HOUSING AND FEEDING BRIDGE AND BUILDING MAINTENANCE OF WAY CREWS

By F. E. Weise
Chief Clerk, Engineering Department; Chicago, Milwaukee & St. Paul, Chicago, Ill.

We are told that labor is scarce, that it is hard to secure and that it is still harder to hold. This is reiterated so frequently that we cannot lose sight of it. Under such conditions workmen are inclined to be uneasy and there is a tendency on their part to make frequent changes. Anything that will serve to make men more contented with their jobs will do much to help eliminate the waste that is the sure result of constant changing, because the breaking in of new men is an expensive process, and it is difficult to say just what it amounts to in dollars and cents. Present conditions emphasize the fact that it is not only necessary to pay high wages in order to keep up the working force, but working conditions must be improved and everything possible must be done to keep the workmen in efficient working condition.

The railroads more than any other class of employers are obliged to cope with most varied working conditions and situations, each one with problems that are peculiarly its own. Even on the same railroad conditions vary greatly. The climate may be dry or moist, warm or cold; one line runs through the desert, another through fertile country; one is in the mountains, the other crosses the prairies; and these situations are subjected to the changes of the seasons. It is seen at a glance that the subject of caring for the workmen needs careful study.

One of the hardest places in which to hold men steadily is in railroad maintenance or construction work, and of the many things that have an influence on the conduct of the men there is none more potent than the way in which they are housed and fed. In order to do effective work, and render efficient service, a man must be in good health, and the primary object of the camp should be to keep him physically and mentally fit for his work. Good, wholesome, properly cooked and well served food; comfortable, clean and well ventilated sleeping quarters; provisions made for bathing and recreation will accomplish this and secure the good will of the men. Good will brings about coöperation, and will be reflected in the amount and quality of the work accomplished. The supervisor in charge of the work, the engineering and office force and the foremen should at all times maintain pleasant relations with the men working under them, without encouraging undue familiarity. Discipline must be maintained and it can be done in a manner that will claim respect and win regard. Whether a camp is good, bad or indifferent has so large an effect on the working qualities of the men, that it demands special consideration. Men who are properly fed and housed and who receive considerate treatment will render more effective service, and perform a greater amount of work than men who are dissatisfied and discontented. The general contractor has paid more attention to this question than the railroads and much may be learned from his experience.

While all of the factors making up a camp and its life are important, the one to receive first consideration is the housing of the men, which may be divided into three classes.

(a) The work of some crews extends over so large a terri
that it is necessary to house the men in cars in order that they
be transported from station to station as the work requires.

(b) The work of other crews is confined to a more limited te
tory that can be readily covered by travelling on trains or motor
and for such forces permanent quarters may be established.

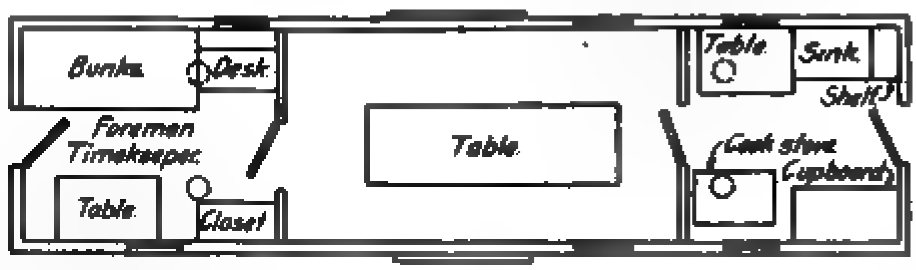
(c) The third class consists of crews organized for some spe
large jobs, and for whom temporary camps are built.

In all classes the same results are aimed at, namely, to keep the
as nearly 100 per cent efficient as possible and to make them conte
in order to minimize the desire for change of location.

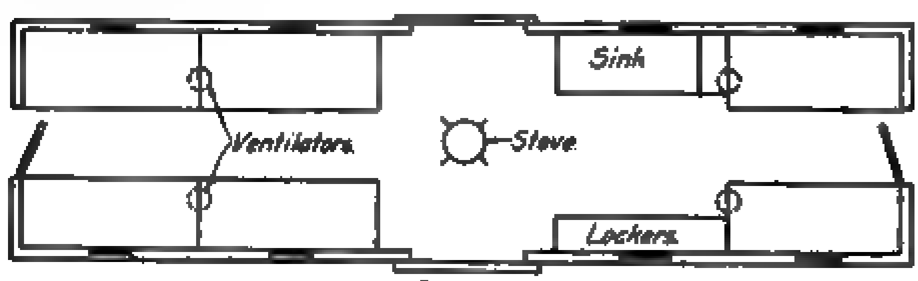
Portable Camps

Let us first consider the housing of men in cars. It has been q
a common practice in the past to house crews in old cars unfit for c
mercial service and especially was this done for extra gangs in w
a complete camp on wheels was established. This practice is gradu
becoming obsolete because equipment is too valuable to be tied u
this manner and cars are only being used for crews that must
moved frequently Where possible it will be found to pay to fit up
for the purpose of housing men.

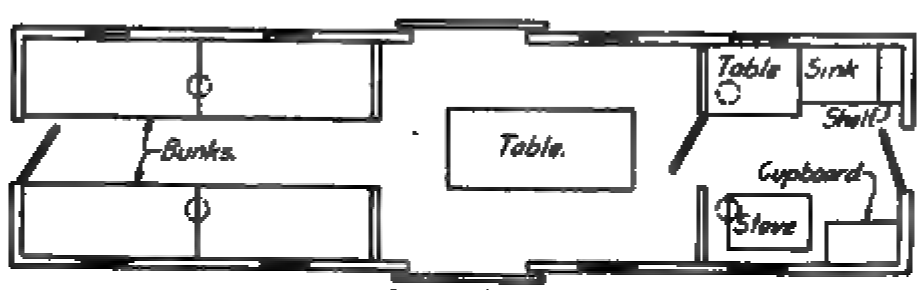
There are many layouts showing arrangements of kitchen, di
room and bunks. It is something like building a house; every
has his own ideas and one plan may be just as convenient as anot
Mr. J. W. Powers, supervisor, New York Central Lines, submits p
for a mess car, bunk car and combination car that are good an
another cut are shown three suggested arrangements for combina
cars. When it can be arranged for, cars specially designed and
for housing crews will give more satisfactory service. Steel b



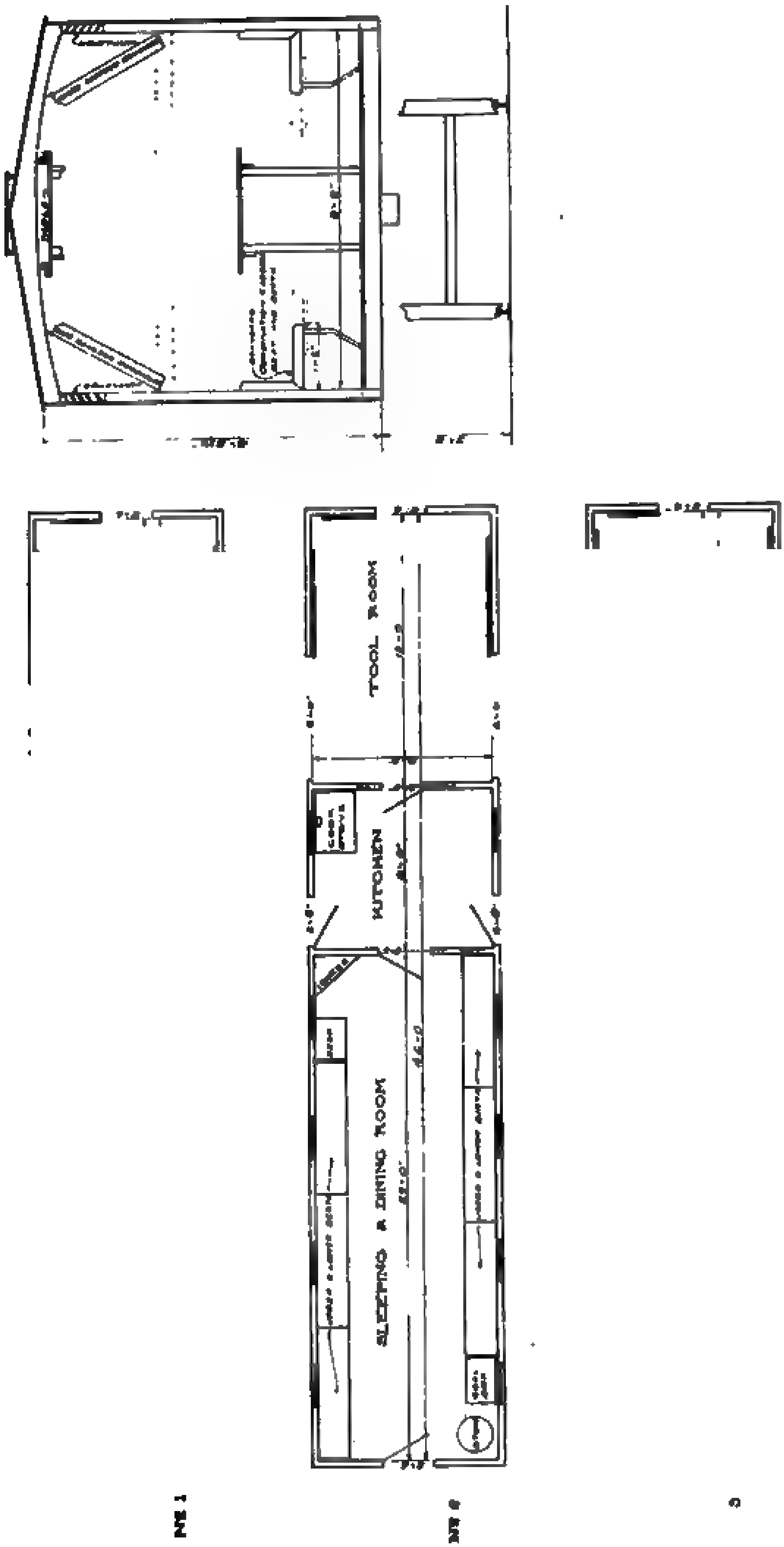
Mess Car



Bunk Car

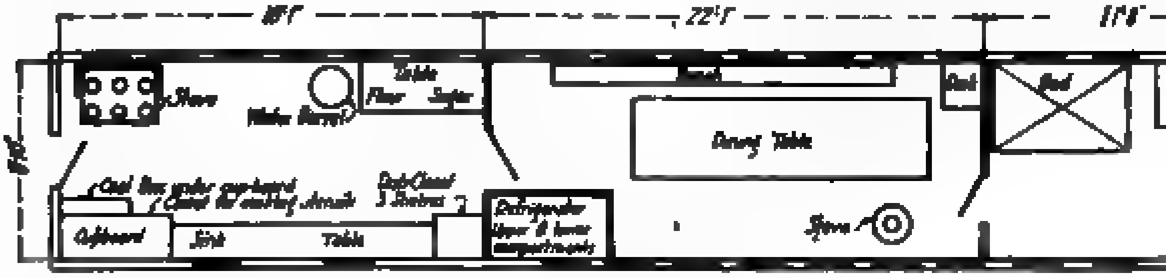


Combination Car



Tool and Bunk Cars, Chicago, Milwaukee & St. Paul Ry.

should be provided for sanitary reasons and each man should ha
separate locker. Cleanliness must be the order of the day and e
man in the crew must do his bit in that direction. Toilet faci
should be provided. A number of so-called waterless or chemical
ets have been placed on the market and have proven both practica
reasonable in price. A careful study of the different kinds wi
found worth while. The problem of feeding the men is similar wh



COOK CAR
BOSTON & MAINE R.R.

the kitchen is in a car, a tent or a permanent building and will be
cussed farther on. Every kitchen car should be provided with a
frigerator or ice box and it should be so placed that it is accessib
daily inspection. It should frequently be given a thorough clea
and drip pans scalded.

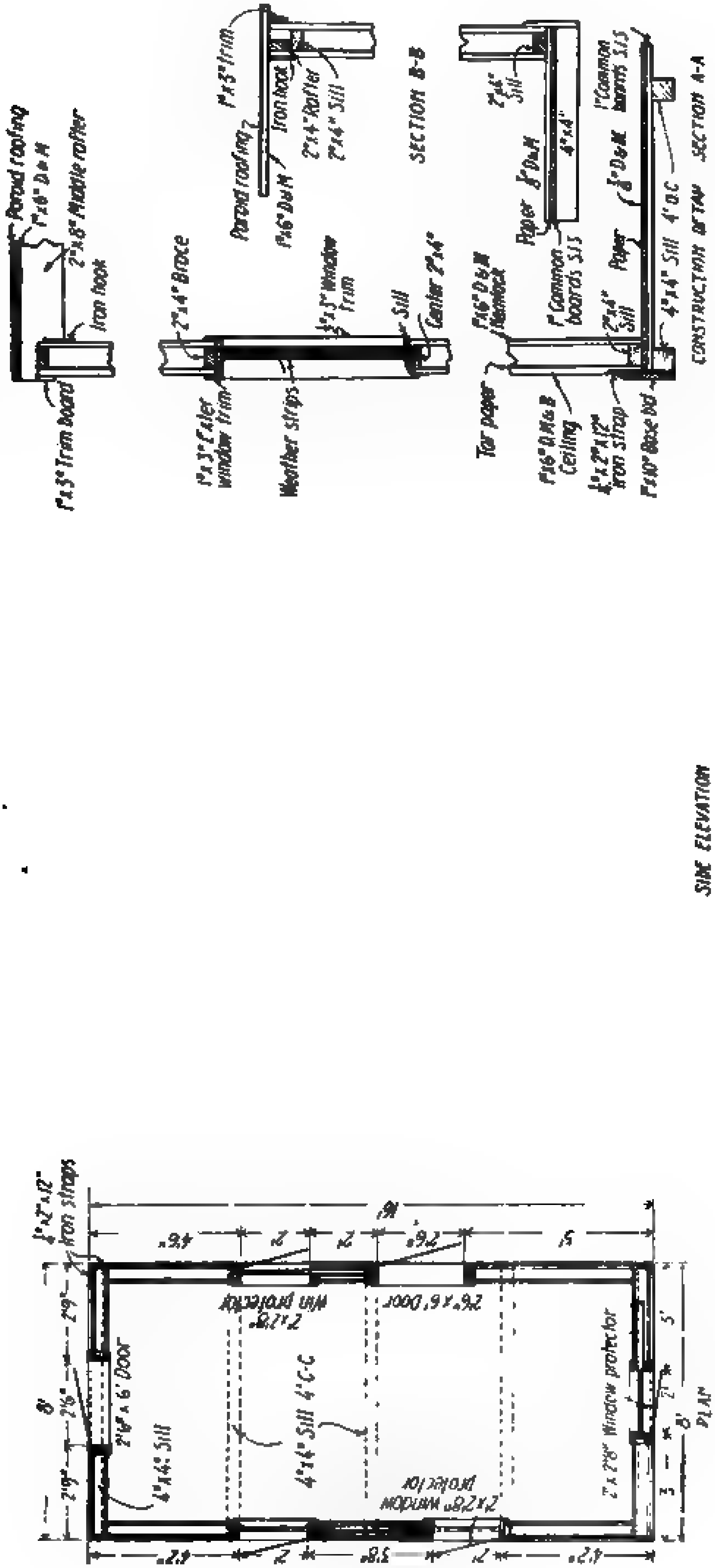
When men can be located at one point and cover their terr
by trains or motor cars, it is possible to provide them with perma
and comfortable buildings. Such buildings are mostly of frame cons
tion and may be as varied in size and arrangement as the requiren
demand. Some railroads have built them of concrete, others cons
a framework, covered with wire mesh and plaster, making pract
a concrete building. Again old car bodies are used either singly
pairs with a roofed space between. The Chicago & Northwestern
a plan for a portable building which can be taken apart readily
shipped to another location if desired, thus making it applicab
either temporary or permanent locations. The building which is
trated herewith is 8 ft. by 16 ft. over all with a shed roof 7½ ft. hig
one side and 8½ ft. on the other. The sides, ends, floor and roof a
separate pieces for convenience in handling, transporting, erectin
taking down. A portable building of this size has many advantages
from those just given. It can be located any place whether th
cessible space is large or small, and it can be disinfected when t
down by treating it with a solution applied with a brush. The b
ings can be taken down and loaded on cars at a cost not to excee
each, and can be unloaded and erected at another location for a
amount. (See illustration on P. 141.)

In hot and dry climates it is commonly the practice to use wh
known as a Panama roof. A building is first roofed in the regular
using prepared roofing or any form or construction that will be w
tight. Studding is then fastened to this roof and a false roof of bo
which need not be water tight is then put on, leaving an air spac
six or eight inches between the roofs. This form of construction
very effective protection from the sun's rays.

Temporary Construction Camp

Let us next take up the study of the camp of temporary cons
tion for construction work. When it has been decided that a cam
to be established, the site of the work should be examined carefully
the location of the camp determined upon by considering the condi
that will make it habitable. Location, water supply, drainage and sa
tion should be given careful study.

If located on the railway company's right of way, the space ma
limited and the buildings will have to be placed in a row. If so



Portable Building, Chicago & Northwestern Ry.

office building should always be between the dining and the sle quarters. In some cases sufficient unused land is available so allow a more compact arrangement, and in others the physical c tions will, in large measure, control the layout. Camp buildings sh be located on high ground whenever practicable so that the na drainage is away from the buildings and insures rapid drying out rains. The arrangement of the buildings, and the plan of the buil themselves will depend somewhat on the location, the material th available for their construction and the season of the year during the camp is to be in use. If the camp is to be in operation durin winter as well as the summer, the buildings must be of a more stantial type that will withstand stormy weather and keep out the A camp which is to be used only a few months in the summer may be of a very temporary form of construction. Most large piec work requiring construction camps are apt to extend over a perio a year or more, and while the buildings are styled temporary build they must be substantially built.

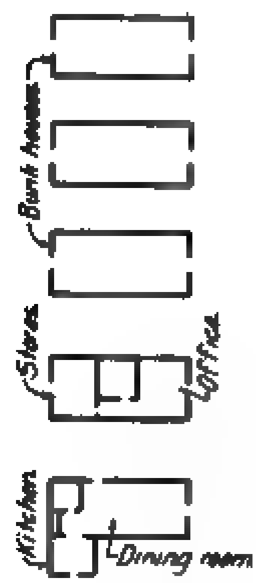


Fig 1

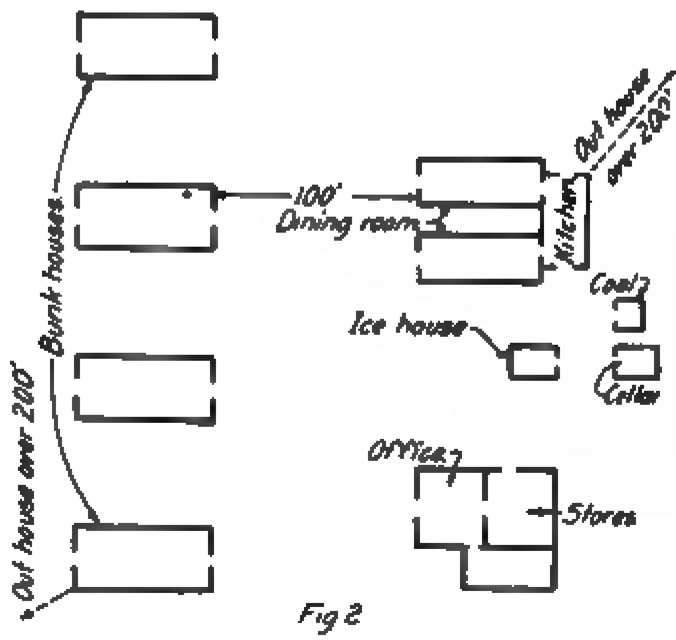


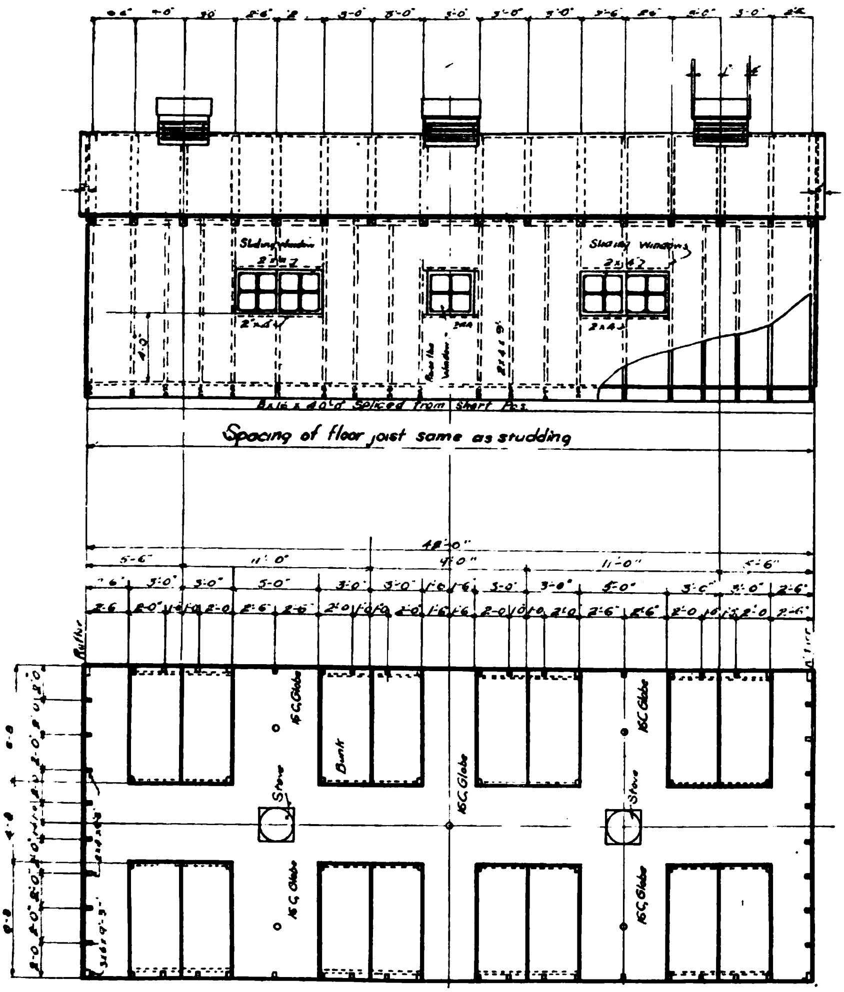
Fig 2

All camp buildings should be built high enough above the gr to enable a man to clean up underneath. The space under the bui is then easily inspected and no old clothes or rubbish should be all to accumulate. In the autumn this space should be enclosed as a tection against cold. The buildings should be equipped with stov other heating apparatus, not only for the warmth of the occupants to dry the rooms out in damp weather.

Office Building

The office building should be of construction similar to the camp buildings, and large enough to provide for an office for the t action of business and the performance of the necessary clerical and drafting, and a storeroom for the camp supplies and the con sary. Sleeping quarters for the engineer and office force should be provided, either in the same building, or in a lean-to communic with it.

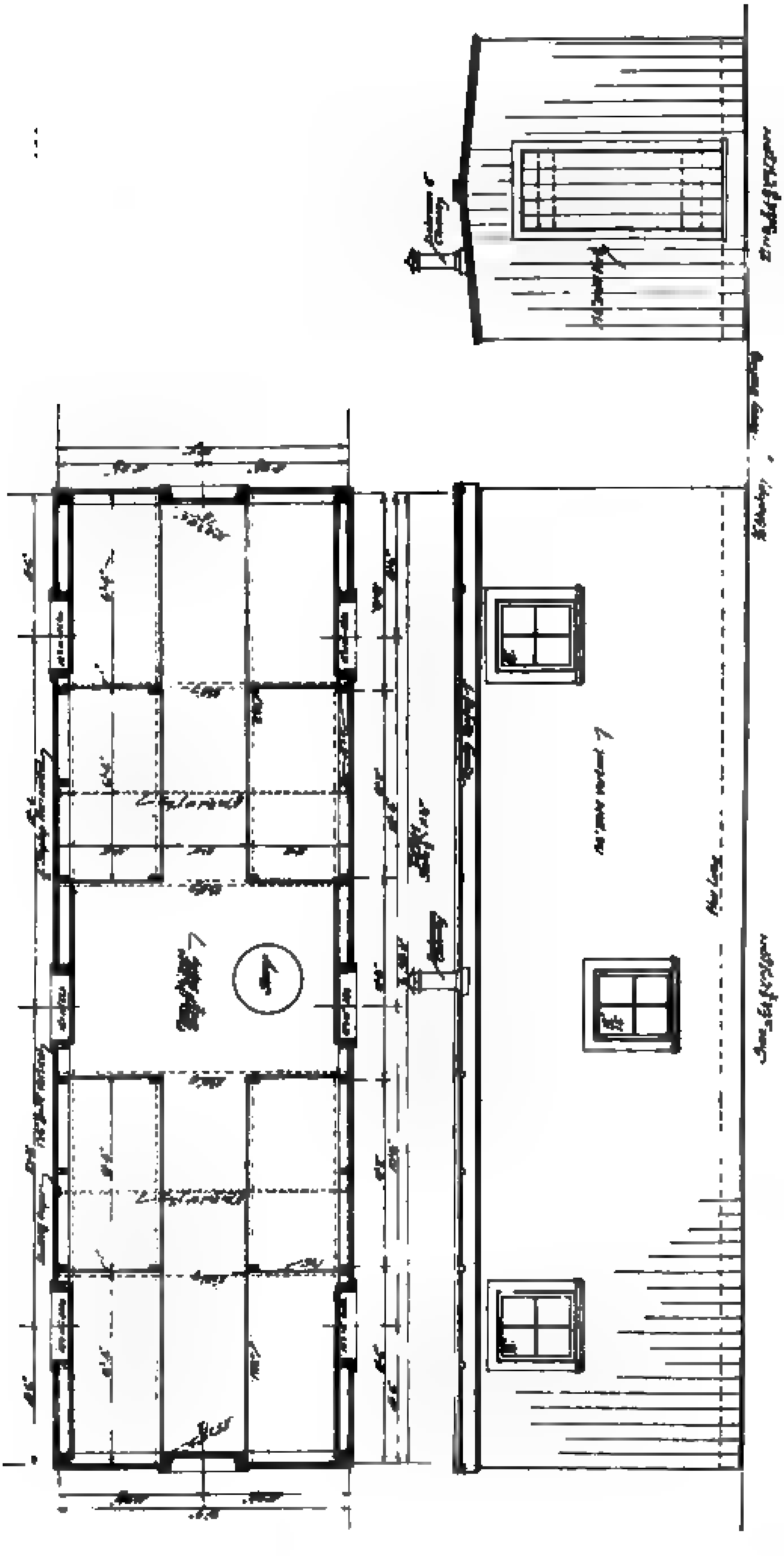
The illustration shows two arrangements that have been used isfactorily, and also suggests the location of the various camp build In both cases it is to be noted that the office building is so located the kitchen and dining room are easily supervised and thus promisc feeding can be guarded against.



Bunk House, Chicago, Milwaukee & St. Paul Ry.

Dining Room and Kitchen

For the average camp, the dining room and kitchen should be in one building and separated by a partition. In the dining room end sufficient tables should be provided so that the entire force may be served at one time. When the camp is not too large, the building should be long and narrow, the dining room being at one end and the kitchen at the other with entrances at each end and a communicating door between the kitchen and dining room. The dining room should be wide enough to provide for two long tables at the sides with an ample aisle between, which will permit waiters to pass back and forth freely. This form of building can be loaded on a flat car and transported from one location to another. For larger camps it may be better to construct the building in the shape of a "T," in which the dining room is one large room and the kitchen an annex at the center of one side.

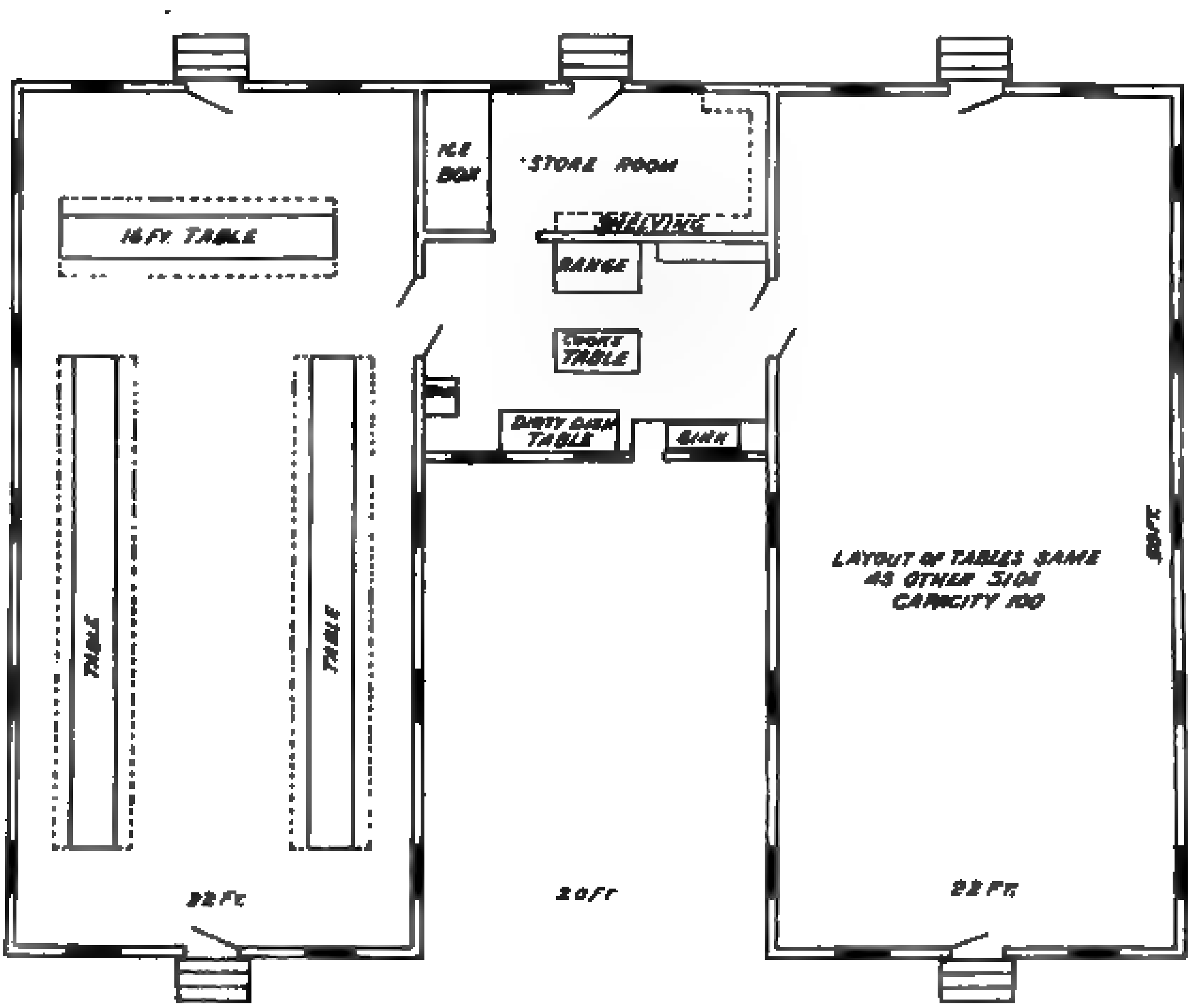


Bunk House, Chicago, Milwaukee & St. Paul Ry.

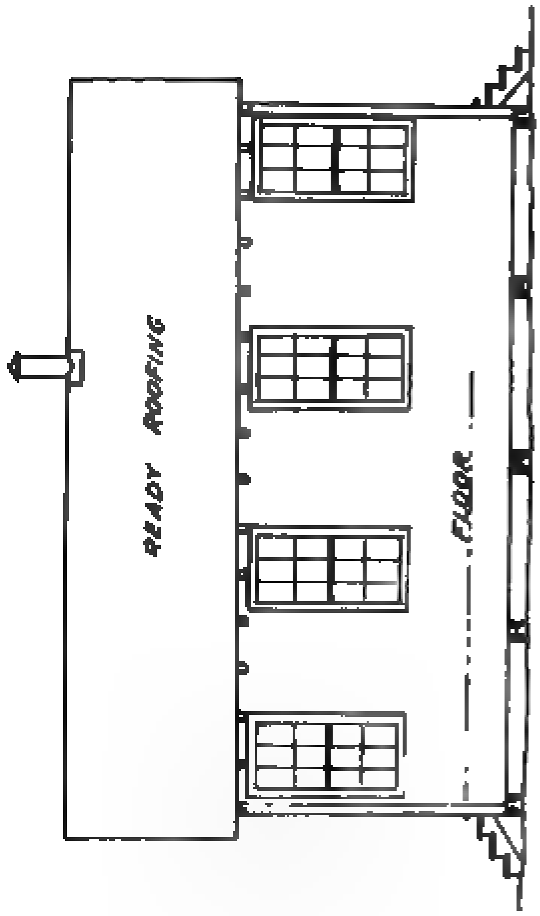
Another good plan consists of three adjoining buildings placed in the form of a letter "U," and provides for two separate dining rooms with a common kitchen. This plan is desirable where the force is apt to fluctuate. When the force is small, one dining room may be closed, and as the work nears completion, one building may be removed without interfering with the camp routine.

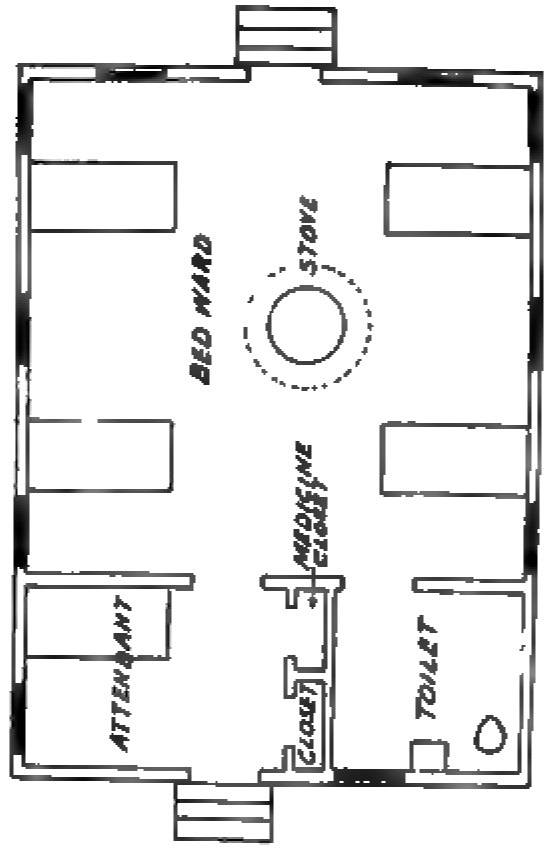
Whatever the arrangement decided upon, provide liberally for windows, in order that in cold weather, the dining room will be well lighted and in hot weather the windows can be thrown open. Nothing is more conducive to cleanliness than plenty of light, and it is the common experience that rubbish will accumulate in dark places. Screens for windows and doors are an absolute necessity, and a constant effort must be made to eliminate flies, ants, roaches and other pests. Frequent scrubbing with a liberal use of hot water and soap will be of great help, and a good rule is to scrub the kitchen every day and the dining room twice a week. The dining room and kitchen floors should be swept after every meal.

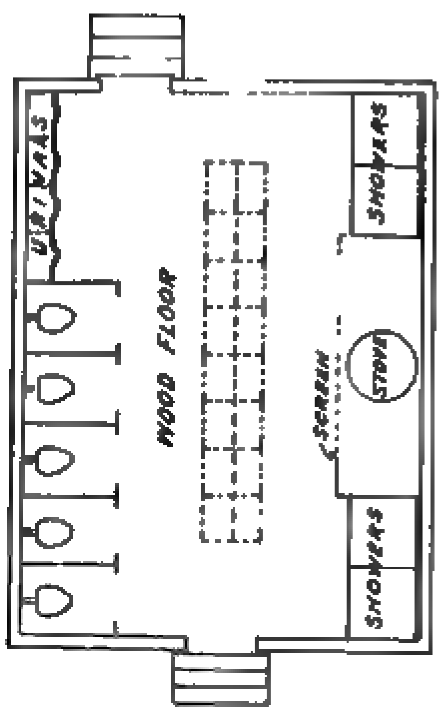
It is usual to provide long tables about 30 in. wide with long benches at each side. Sometimes smaller tables are provided, seating four to six men each, but it is found that this plan requires more waiters and that the men cannot be served as quickly. It will be found more satisfactory to the men to eat at the same table with those they work with and, therefore, each man is assigned to a definite place by the clerk in charge of the camp. The tables should be strongly built and the top at least made of surfaced lumber in order that it may be kept clean.



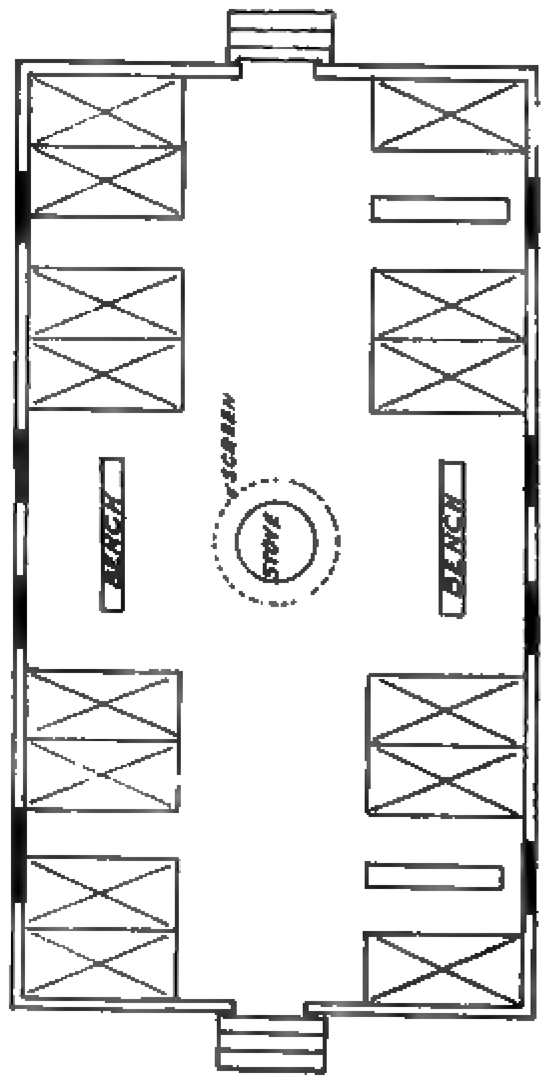
ILLINOIS CENTRAL COMISSARY BUILDING WILDWOOD, ILL.







TOILET— 18 x 24



Kitchen Utensils, Dishes, Etc.

Considerable thought should be given to the selection of this part of the outfit. The kitchen utensils should be chosen for their utility. They are in constant use and must be strong and durable. Without being unnecessarily extravagant, select ware that can most easily be kept clean. A little expenditure on quality is a good investment here, because the cook and his helpers will take pride in keeping good equipment in good condition.

The dishes in the dining room should be of a good grade of heavy china or crockery. Tin or enameled dishes have found favor in the past because of their overrated quality of unbreakableness, but this is more than offset by their disadvantages. Tin dishes are hard to keep clean, or at any rate clean looking. Steel knives rubbing on tin or enamel produce a disagreeable and irritating noise, and also are apt to chip off the enamel. They allow the food to get cold too quickly.

Not only can crockery be kept clean more easily, but it adds more to the meal than at first thought seems possible. An office man may find it a little difficult to appreciate this. Should he go on a hunting or fishing trip for a few days, he rather enjoys having his meals served in tin dishes. As a matter of fact, it is the novelty of the change that he enjoys. Unaccustomed activities, together with unlimited fresh air, make him so ravenously hungry that he takes no account of the service. How long would the novelty last? The man in the construction camp is in a different position. Camp life is his daily existence, and there is a natural craving for better things. The same food will be twice as appetizing if served on crockery than if served on tin or enamel, and it makes the man feel that he is considered somebody. Actual experience shows that the breakage of crockery is not large and that its expense is not much greater than other ware. The following list will serve as a guide in preparing for the first requirements of a camp of about 50 men:

Kitchen Utensils

- 1 Range for Coal 28"x54"
- 2 Griddle Irons 16"x24"
- 6 Galvanized Pails—12 qts.
- 2 Washboards
- 2 Stock Pots—10 Gal.
- 6 Sauce Pans—6½ qt.
- 4 Dish Pans—30 qt.
- 4 Frying Pans—12"
- 1 Skimmer
- 2 Flesh Forks
- 2 Funnels
- 12 Pie Tins—9"
- 12 Coffee Pots
- 1 Flour Scoop
- 1 Pot Chain
- 1 Nutmeg Grater
- 2 Rolling Pins
- 1 Pastry Brush
- 3 Can Openers
- 1 Coffee Strainer
- 2 Butcher Knives
- 6 Paring Knives
- 1 Cleaver
- 1 Ice Pick
- 6 Scrub Brushes
- 12 Dish Towels
- 12 Waiter's Aprons
- 1 Alarm Clock
- 2 Roasting Pans 22"x22"
- 2 Cake Turners
- 2 Galvanized Tubs
- 1 Stock Pot—5 Gal.
- 1 Boiler—20"
- 6 Colanders
- 6 Pudding Pans
- 4 Soup Ladles
- 2 Basting Spoons—18"
- 6 Water Dippers—1 qt.
- 1 Measure—1 Gal.
- 6 Bread Pans—11"x7"
- 2 Potato Mashers
- 1 Flour Shaker
- 1 Grater
- 1 Egg Whip
- 1 Cutting Board—18"x24"
- 1 Meat Chopper
- 12 Tin Cups
- 1 Scale with scoop
- 2 Bread Knives
- 1 Butcher's Steel
- 1 Meat Saw
- 1 Ice Tongs
- 6 Wash Basins
- 24 Roller Towels
- 2 Mirrors—9"x12"

Dining Room

Crockery

- 60 Coffee Cups
- 60 Dinner Plates
- 6 Platters—11½"
- 60 Soup Bowls
- 12 Butter Dishes
- 6 Water Pitchers
- 60 Saucers
- 6 Platters—13"
- 36 Vegetable Dishes
- 12 Sugar Bowls
- 6 Milk Pitchers
- 60 Sauce Dishes

Glassware

6 Vinegar Cruets
6 Salt Shakers
60 Water Tumblers
6 Syrup Jugs
6 Pepper Shakers

Cutlery

60 Knives
60 Tablespoons
60 Teaspoons
60 Forks

Kitchen

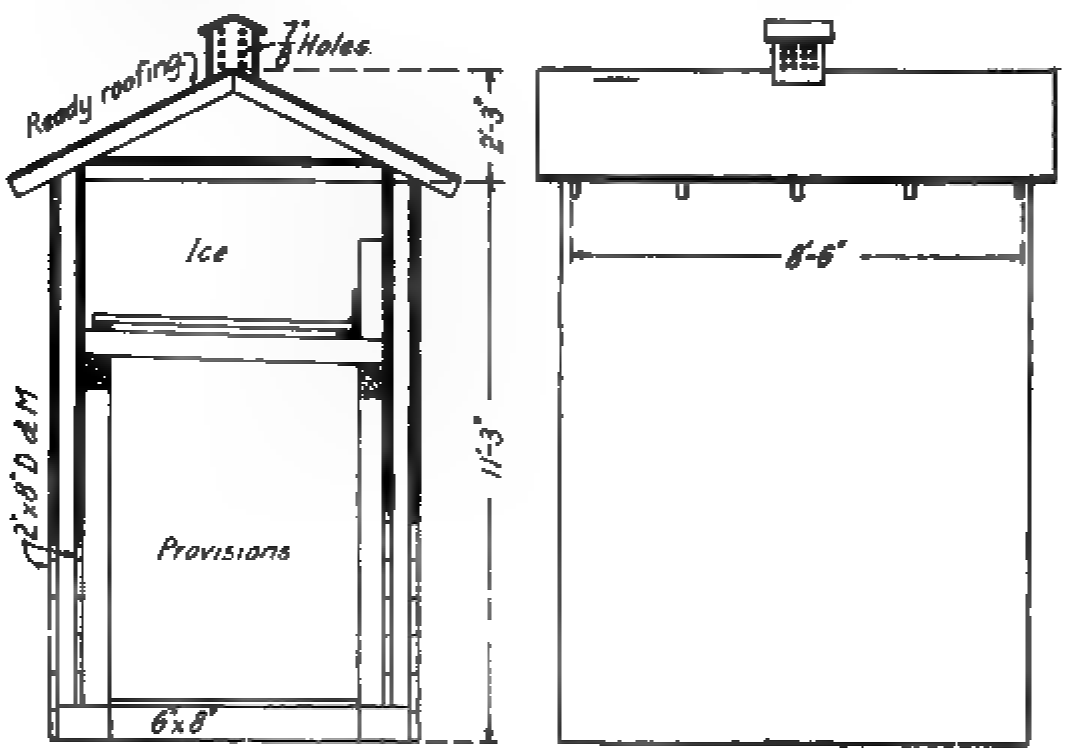
Whether the kitchen is part of the same building or not, it sh communicate directly with the dining room, but be separated from i a partition and a screen door. There should be a door opposite the ing room through which supplies and fuel are received and refuse t out. It should also be provided with plenty of windows and a tilator in order that the heat and odors from the range may be from the dining room. In the summer time the windows and d should be screened The kitchen should be equipped with a range, ing table, sink for washing dishes, cupboard, shelving and a pantry. pantry is used to store such supplies as are required from day to but not in any large quantity. The large stock of supplies should a times be kept in the storeroom that connects with the office, and cook will draw therefrom what is needed from day to day.

The cook and his helpers should have sleeping quarters eithe the main building or adjoining the dining room, but if in the building, they should be completely partitioned off from the dining r and the door be kept closed.

A refrigerator should be provided, and it will be best to have a separate building located conveniently to the kitchen. This can e be constructed from matched lumber. The one shown in the illu tion is inexpensive and easily built.

For a camp lasting several seasons, a cellar, roofed over and ered with earth, will provide an excellent place for keeping pota beets, turnips and other vegetables.

The force required for a camp of about 150 men will consist cook, three flunkies and a commissary clerk. Larger camps will re



additional help in proportion. Much depends upon the cook in the conduct of the camp, not only in providing satisfactory meals, but also in keeping the expenses within proper limits. In small camps and where the cook is found to be thoroughly reliable, it may be found practical to furnish him supplies from day to day without keeping a daily record, but in the larger camps, it is necessary to require him to make requisitions for such supplies as he needs to equip the pantry from day to day. These orders are filled by the commissary clerk, who enters the prices opposite each item, thereby keeping in touch with the daily expense of the camp. The commissary clerk is to keep records of all supplies received from day to day, and of all supplies turned over to the cook each day, and on the morning of the first day of the month he is to make an inventory of all supplies on hand. At the time the inventory is taken, he will make up a statement showing the cost of the supplies used for meals, and all other expenses in connection with the camp, such as oil, fuel, wages, etc. He will keep a record of the number of meals served each day, and at the end of the month will make up a complete statement showing the expense of the camp for the current month, the number of meals served, and the average cost per meal, and also the same information for the entire period since the opening of the camp. Blank forms are submitted which are all very simple and need no further elaboration.

The store room and refrigerator should at all times be stocked with a liberal supply of food, but well kept under control for fear of encouraging extravagance or waste on the part of the cook and his helpers. Arrangements should be made for securing fresh meats at stated intervals and fresh vegetables, butter, eggs and milk can usually be provided for locally. Local purchases must be paid for in cash from day to day and a working fund will be required to take care of them. The cook will perhaps prefer to use canned goods almost entirely because of the ease with which they can be prepared for the table, but it is more economical and better for the men to use fresh vegetables when in season.

The bill of fare will need quite a little study and consideration. While it is planned to give each man a sufficient amount of good, plain and substantial food, properly cooked, at each meal, care should be taken not to serve the same thing every day, but to provide the variety necessary to everyone. Many of the complaints made of the food may be traced directly to a lack of variety and not to the quality of the food or the way in which it was prepared. It will be found that most men crave pies, puddings and pastry, and it will be found necessary to use discretion in the matter. A little extra attention to these matters on Sundays and holidays will go a long way toward keeping up a good feeling in the camp.

It is quite generally the custom to provide free meals for the engineer in charge, the commissary clerk, the cook, the flunkies and the camp help, but the practice should not extend beyond that. All others should either pay for their meals in cash or sign orders for deductions from the payrolls. The boarding of transients should be discouraged, but when this is necessary, they should pay a higher price per meal than the regular force in order that they may share in the supervision expense which is not covered in the prices charged the workmen.

Meals should be served at regular hours and promptly, and it should be the aim at all times to give the best possible service that conditions will permit. Special attention should at all times be given to cleanliness. Waiters must be instructed to put on clean aprons before each meal. After the meal is finished, the dishes are collected and taken to the sink where they are thoroughly washed with hot water and soap. Many of the minor ailments of men in a camp may be traced

CAMP NO.-------LOCATION------------------------------

Employee Receipt No.-----Date------------------------
Received from Commissary Clerk the following articles the cost of which is to be deducted from my wages at the next pay day

No.	Description	Rate	Amount	
	------------------------- Signature.			

directly to the improper washing of dishes. The floors of the d room and kitchen must be swept after each meal. The tables a be scrubbed with soap and hot water after each meal, the dining twice each week and the kitchen floor every day. After the dishe washed, they are put in place on the tables ready for the next meal the whole covered with suitable cloths. Dish cloths and towels a be thoroughly washed in boiling water after each meal and then

Garbage

Garbage should not be allowed to accumulate. A barrel havi tight fitting cover should be provided, and in this all of the ga is collected. Once a day this barrel should be taken to a conside distance from the camp and the contents buried, or better still, bu A garbage incinerator can be constructed easily and cheaply, and by far the more desirable plan.

Water Supply

If a well of good drinking water can be secured, it will be f a wonderful asset to the camp. The well should be located not n

MONTHLY INVENTORY OF SUPPLIES DATE----------------------19--

CAMP NO.-------LOCATION--

Total number of meals served---------------------------Assistant Engineer.

	Amount on hand last inventory		Received during month		Consumed during month		Amount on hand this date	
	Amount	Cost	Amount	Cost	Amount	Cost	Amount	Cost
Allspice								
Apples (Canned)								
" (Evap.)								
Apricots								
Bacon								
Baking Powder								
" Soda								
Tomatoes								
Turnips								
Vinegar								
Yeast								
TOTALS								

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY
Engineering Department

R E P O R T O F C A M P

At----------------------for month ending-----------------19---

Date camp was opened --------------191---	Previous Report	Current Month	Total to Date
Cost of Kitchen & Dining Room Utensils & Equipment			
Cost of Camp Labor in Kitchen, Dining Room & Bunk Houses			
Provisions and Supplies			
Total			
Number of free meals furnished			
Number of paid meals furnished			
Average cost per paid meal			
Receipts - Cash for meals			
Board Deductions			
Provisions sold			
Total Receipts			

Correct:

----------------------- Commissary Clerk. ----------------------- Assistant Engineer.

than 100 ft. from any camp building, and preferably more, and if possible on a rise of ground. It should be curbed at least one foot above the ground level, and the surrounding space filled in with earth to slope away from the well. It should be properly covered and protected so that nothing may be thrown into it that will pollute the water. It goes without saying that outhouses and the disposal of garbage should be kept at a safe distance, not less than 200 ft. away.

Sometimes a good spring is located in the near vicinity and the water can be piped to the camp. Should the camp be so located that water from a river or lake must be used, the problem becomes more serious, and extraordinary precautions must be taken to keep the water from being polluted. Water taken from a lake or river must usually be boiled before it is used for drinking.

Commissary Store

It is sometimes necessary that a commissary store be run in connection with the camp, especially when the camp is located at some distance from a town. This commissary store is to be in charge of the commissary clerk, and should carry in stock such goods as are most frequently called for and used by the men, such as overalls, shirts, socks, blankets, heavy shoes, overshoes, and standard brands of tobacco. This list may be extended as warranted in the judgment of the engineer, but in no case should it include liquor of any kind.

When a camp and commissary store are run by the railway company, it is not for the purpose of making a profit, but care should be used to see that it is not run at a loss. For that reason careful account-

ing is necessary, and precautions should be taken to prevent pet thievery or grafting.

A commissary should not be run in competition with a local sto In the first place, the conduct of a commissary is an added care th ought to be avoided if possible, and in the second place, it is the desi of the railroad company to encourage business along its lines.

The commissary store should be run on a strictly cash basis.

Accounting

All accounting in connection with the camp and the commissa store should be as simple as possible, but separate books should kept for each in order that any profit and loss may be allocated to t right source. Two books for each will suffice, one a combined daybo and journal in which all transactions are recorded, and which at the e of the month will show the total debits and credits, and the other cash book which records the cash transactions only, and should be b anced each night with the amount of cash on hand. In the daybo journal for the camp, the debit entries consist of kitchen utensils a supplies, fuel, oil, food supplies, and wages of camp employes. T account begins each month with the inventory of supplies on ha On the credit side will be entered the board of the men, receipts f supplies sold and the inventory of supplies in the store room at the e of the month. The difference between the totals of the debit and cre entries will show whether the camp is being run at a profit or a loss.

Price of Board

It is quite customary, in determining the price to be charged f board and lodging, to charge the employe what he would have to p ordinarily in nearby towns and then furnish as good board as possib with a view to having the camp pay for itself. The cost of the mea furnished to those employes needed to operate the camp is consider a part of the camp expense. Should there be any employes on the wo whose expenses are paid by the Railway Company, the cost of t meals should be charged to the work and the camp given credit. the beginning of the work the force may be comparatively small, a at the close of the work it will gradually diminish, making two perio during which the camp will not pay for itself. It should, therefore, planned that when the force is at its maximum, the camp should ma some profit in order that, when the work is closed, the accounts w about balance. In order to do this the affairs of the camp will ha to be planned and watched carefully.

It will be found more satisfactory to use a rate per week than a ra per meal. In the former case the matter of lost meals need not watched, and there are apt to be fewer misunderstandings. It will al insure a more regular attendance at the camp meals on Sundays a holidays. If a rate per meal is decided upon, some form of meal tick will have to be provided, which is punched as the men enter the dini room.

As a general experience a camp of 25 men or less will not pay e penses; a camp of from 50 to 75 men can be made to come out abo even, and a larger camp will show a slight profit. This bears out t previous statement.

Bunk Houses

The construction of the bunk house will depend upon the locality and the season during which it is to be used. If in use during the winter, it must be built quite substantially so as to withstand storms and cold. If the bunk house is to be used only for a few months during the summer or in very warm climates, it may be of very light construction, but it should always be so built that it will keep out the rain. It

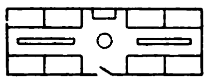


Fig. 1. Bunk House for 16 Men.

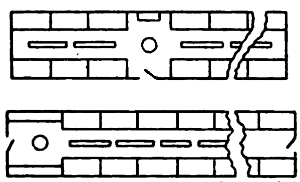


Fig. 2. Two Layouts that Can be Extended

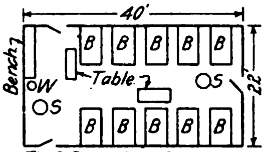


Fig. 3. Bunk House for 40 Men.
W = Water barrel. S = Stoves.
B = Double deck steel bunks, 4 men each.

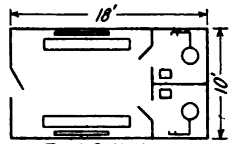


Fig. 4 Bath House.

should be built high enough above the ground to enable a man to get under it, and a positive rule should be made that the space underneath be kept clean and that no accumulation of rubbish or old clothes will be allowed.

Bunk houses or sleeping quarters should not be made too large. It is much better to have a number of smaller houses than to endeavor to make one building large enough to provide for the entire force. There are apt to be disturbing factors during the night, such as someone being taken sick or other unusual occurrences, which will disturb the entire camp if all the men are housed in one building. For the common labor, it has been found desirable to have houses that will accommodate from 30 to 40 men each, although some would limit the number to 24. For the housing of sub-foremen, carpenters and other high grade labor, houses accommodating from 12 to 16 men are preferable.

Bunk houses, built rather long and narrow with bunks on either side and a central aisle, appear to be the most satisfactory and have the added advantage that they can be loaded on cars and transported to other jobs. Old car bodies, when available, may also be used. Sketches submitted show various arrangements. In very large camps it is at times decided to build houses that will accommodate more than 40 men, but because of their size, they are more costly.

It is quite customary to build bunks of wood as shown in the drawing, but great improvements have been made in the last few years in the manufacture of steel bunks, and they are being installed in many camps because of their greater comfort, and the ease with which they are kept clean and sanitary.

There is one item which at first thought may seem an extravagance, but which will do much to hold the men and that is the installation of in-

dividual lockers. Metal lockers may be deemed too expensive but
are more sanitary. They should be in good condition when the ca
taken down and can be used elsewhere. Wooden lockers with doors h
an opening of wire mesh can be easily and cheaply constructed.
should be built in two tiers, two feet square and four feet high,
enough to hold a suit case. Good locks with individual keys shou
furnished. Each man is given a key attached to a metal tag be
the same number as the locker The key is charged up to him and
obliged to turn it in when he leaves before receiving his pay. Lost
are charged to the men and deducted from their pay.

In spite of the utmost precaution there is likely to be trouble
vermin. Men are likely to carry them from other camps in their c
ing or in other ways. A rule should, therefore, be made that o
month each bunk house is fumigated. After the men have left for
in the morning, the bedding is all taken out, the mattresses turne
doors, windows and ventilators closed, and sulphur candles bu
Use twice the dose that is recommended by the manufacturer, be
bunk houses cannot be sealed as tightly as rooms in a house.
fumigation the bunk house should be thoroughly aired before
occupied again.

Camp Man

The sleeping quarters are kept clean and in order by a camp
whose duties are to sweep, carry coal and keep the bunks in o
Bunk houses, except in very warm climates, or when used for o
short period during summer months, should always be provided
stoves. Railway caboose stoves are well adapted to that purpose
cold weather men must have a place to warm up, and in wet wea
there is always clothing to be dried out. Sleeping quarters should
be allowed to become damp and musty.

A water barrel should be provided at each end of each camp b
ing for use in case of fire. In the winter time the water shoul
heavily salted or saturated with some anti-freezing mixture. It sh
be the camp man's duty to examine each barrel every day, and see
it is filled and ready for use. A pail with a rounded bottom, marked
be use only in case of fire," should be provided for each barrel.

Night Watchman

A camp night watchman on duty all night is also a necessity
should be his duty to see that the lights are put out at the proper
(nine o'clock is a good hour to set), to keep up the fires in winter,
to see that late comers, or those who are inclined to be up late, do
disturb the remainder of the camp. Men will sleep and rest bett
they know there is someone on guard to see that they are not distu
or robbed, and a good night's sleep means better work the next
The watchman is also there for prompt action in case of sickness
or other emergency. It is also his duty to wake the men at the pr
time each morning, first the cooks and flunkies, in order that break
may be started on time, and then the men, to get them up in time
breakfast and thus start the day right.

Lighting

When it can be had, electricity is the ideal method of lightin
camp, and it can frequently be supplied without undue cost. The c
may be near a town having a power plant, or near some power

from which current may be obtained. The electric light will do much to insure cleanliness; a temporary installation is not expensive, and it will also materially reduce the fire hazard. On a large piece of work of long duration where power machinery is used, it will pay to install a lighting plant, and especially where the electric current can also be put to other uses.

Where ordinary lamps must be used, they should be kept clean and in good order at all times, and their placing should be so safeguarded that they are not liable to be overturned when being lighted, or knocked over when men are passing back and forth. Bracket lamps fastened to the wall as high as possible and equipped with metal protectors may be used. In many places lanterns will furnish ample light and are safer.

Ventilation

All camp buildings should be provided with sufficient means for ventilation, even though built in the most temporary manner. This refers particularly to the sleeping quarters. Sufficient fresh air without unnecessary exposure to cold and storms will do much to keep the working force in good condition. Should the dining room become too hot and stuffy during meal time the men will complain, and the matter can be easily remedied, but at night men are apt to sleep in poorly ventilated bunk houses without realizing why they do not feel rested and refreshed in the morning. It should be made the particular business of some one man in each bunk house to see that there is sufficient circulation of air before he retires. All windows should be in condition to open and close readily, and the roof should be provided with ventilators. Proper means of ventilation can be installed easily and inexpensively.

Outhouses

Outhouses sufficiently ample for the needs of the camp must be provided, be made as convenient as possible, and located at a safe distance (not less than 200 ft.) from any camp building, where the natural drainage of the ground is away from the camp. The usual procedure is to dig one or more sumps, as may be deemed necessary, and erect suitable outbuildings over them. Such buildings should be kept as dark as possible by painting them some dark color and locating them in a group of trees, because flies shun dark places. They should also be screened. Keep them as clean as possible by sweeping them once a day and scrubbing them twice a week. Provide receptacles for paper. Cleanliness and neatness should not only be encouraged but insisted upon. The excavation for a sump should be quite deep. Once a week the outbuilding should be moved to one side and a layer of chloride of lime and six inches of earth placed over the excrement. When the filling nears the surface of the ground the excavation should be entirely filled and a new sump dug in another location. Chemical or waterless toilets may be necessary in some localities.

It is a common experience that it is comparatively easy to get men to comply with rules for sanitation in camps established for long periods but that they are careless in the small camps established for only a few weeks; therefore strict and definite rules must be laid down and their compliance insisted upon as part of the condition of employment. If the camp is fortunate enough to have a liberal supply of running water so that sanitary closets and a cesspool may be built, these should by all means be provided.

Physicians, First Aid and Medicines

When a very large number of men are engaged on one piece work, or where hazardous operations, such as pneumatic caisson wo are involved, a resident physician should be employed, whose duty is to see that the men are cared for, not only in cases of injuries, also in sickness of any kind Prompt attention to minor troubles usually prevent serious illness He should also be responsible for sanitary condition of the camp. A building should be furnished his use as an office and a hospital. If this work will not warrant employment of a resident physician, arrangements may be made some local doctor to make periodical visits for general service, and respond to emergency calls.

When a resident physician is not employed the camp should provided with medicines and surgical supplies sufficient to render aid to the sick or injured. Such supplies should not only consist bandages, antiseptics, restoratives, etc., for use in case of shock or jury, but also of simple remedies to relieve the troubles to which around a camp are liable, such as colic, cramps, diarrhœa, colds, etc.

It seems almost unnecessary to say that such supplies must be in an intelligent manner, and yet we not infrequently read of cases wh a wrong application has done more harm than good. The man in cha of the camp should be thoroughly familiar with the use of the suppl and he should see to it that others are also instructed in order tha all times there will be one or more men at the camp who can resp to an emergency. Printed instructions should be posted within chest or cabinet containing the supplies, and someone should be signed to the duty of keeping the supplies ready for use and to see renewals are made before the supply of any article becomes exhaus It is also suggested that a copy of the American Red Cross First Textbook be supplied with the medicine chest.

It is also suggested that in addition to having printed rules, all men in the camp be assembled occasionally and given talks on first sanitation, and other things that affect the welfare of the camp. railway company's chief surgeon should designate what is to be and outline instructions for its use.

Following is a list showing the contents of a medicine chest as plied by the chief surgeon of the Chicago, Milwaukee & St. Paul use in camps, and also the printed instructions that accompany it:

Contents of a Full Standard Chest

1.	Quinine, 2 gr.	25 envel
2.	Cough Tablets,	25 envel
3.	Diarrhœa Tablets,	25 envel
4.	Headache or Pain Tablets,	25 envel
5.	Coryza Tablets,	25 envel
6.	Diuretic Tablets,	25 envel
7.	Sore Throat (Tonsilitis) Tablets,	25 envel
8.	Sodium Salicylate Tablets,	25 envel
9.		
10.	Cathartic Tablets,	25 envel
11.	Epsom Salts,	50 envel
12.	Liniment, Solidified,	24
13.	Porous Plasters,	18
14.	Tincture of Iodine (60 per cent),	2 4-oz. bo
15.	Gauze,	15 pack
16.	Absorbent Cotton,	6 4-oz.
17.	Adhesive Plaster,	6 s
18.	Bandages, 2 and 3 in. wide,	12
19.	Vaseline,	2
20.	Eye Drops,	6 bo
21.	Toothache Medicine,	1 b

Medicine Chest Instructions

All Wounds—The aim to protect rather than to treat. Do not wash wo nor apply any foreign substance. Apply a few drops of tincture of iodine, the wound and apply a piece of gauze and, if necessary, cotton and bandage. dle as little as possible.

Small Cuts—Apply a few drops of tincture of iodine and close with a narrow strip of adhesive plaster **placed across part of the cut** and bandage.

Burns and Scalds—Apply vaseline and a gauze bandage, and send to the doctor.

Crushing Injuries Without Bleeding—Apply tincture of iodine, gauze and cotton to the wound, bandage, and send to the doctor.

Bleeding—Apply tincture of iodine, gauze and cotton, and then bandage snugly. If bleeding is severe and spurting, apply a bandage about the limb nearer the body and tight enough to control the bleeding. Treat wound as directed and get the patient to the doctor within three hours.

Fractures or Broken Bones—Apply cotton and two board splints, **wider than limb**, one on each side, and bandage snugly. If skin is broken treat with tincture of iodine as directed. Send to doctor as soon as practicable.

Sprains, Bruises or Lameness—Apply solid liniment with **plenty of rubbing** twice daily.

Colds in Head—Give two cathartic tablets (No. 10) and two or four coryza tablets (No. 5) at bedtime, or one every hour.

Coughs and "Colds on Chest"—Give one cough tablet (No. 2) every two hours, as needed.

Sore Throat—Allow one sore throat tablet (No. 7) to dissolve slowly in mouth every hour.

Constipation and Biliousness—Give one cathartic tablet (No. 10) night and morning and if necessary a dose of salts (No. 11).

Diarrhœa or Cramps—Give one cathartic tablet (No. 10), or Epsom salts (No. 11), and follow with one diarrhœa tablet (No. 3) every hour for a few doses.

Cinders in Eyes—Do not use matches or other harsh material. If unable to remove with a folded piece of bandage, cover the eye with cotton, apply bandage and send to the doctor.

Eye Inflammation—Drop eye drops in the eyes two to four times daily.

Fever—Give two cathartic tablets (No. 10), and follow with one quinine tablet (No. 1) every four hours as needed. If the fever continues, send to the doctor.

Headache—Give one cathartic tablet (No. 10) and one headache tablet (No. 4).

Neuralgia or Pain—Give one pain tablet (No. 4) every three hours if needed.

Rheumatism and Lumbago—Give one sodium salicylate tablet (No. 8) every three hours, if needed.

Chronic Pain in Back—Use solid liniment (No. 12) with plenty of rubbing, or a porous plaster (No. 13).

Scanty Urine—Give one diuretic tablet (No. 6) every three hours and plenty of water to drink.

Toothache—Place a pledget of cotton saturated with toothache medicine in the cavity, or apply to the gums.

Typhoid fever is one of the dangers of camp life that must be guarded against, for if it once gets started the situation is serious. The danger from typhoid may be removed by the hypodermic injection of vaccines. This precaution is being taken by the Government in its military and survey camps. The treatment is very simple and causes the men no discomfort other than possibly a slight grippy feeling that passes off in a day or two.

A record should be kept and reports made of all injuries or cases of sickness even though the application of first aid seems at the time all that is necessary. Later developments are sometimes attributed to these minor injuries, rightly or otherwise, and a definite entry made at the time will do much to determine the justice of a claim.

Steam Plants

It is not uncommon on large pieces of work, especially those involving concrete, to use a steam plant for furnishing power, and when such is the case and it is planned for in advance, the camp may be supplied with hot water at a moderate expense. Refinements (if they may be called such) in outfitting a camp necessarily involve an initial expenditure of material and labor, but many of them pay for themselves in a surprisingly short time, and they accomplish that very desirable feature of keeping the men as nearly 100 per cent efficient as possible, and also satisfied with their jobs. If the job does not require a steam plant, it would still pay to install a heating boiler for the camp alone. A small, elevated tank is easily installed, and this, in connection with the steam plant, will furnish the camp with many desirable features such as

a. Buildings supplied with hot and cold water for washing and cleaning;

b. Buildings supplied with steam heat;

c. Kitchen supplied with a liberal quantity of water for was dishes and scrubbing;

d. Bath house with showers;

e. Laundry in which men may wash their own clothes.

Bath Room and Laundry

A few years ago a bath room and a laundry equipped with hot cold running water would have been labeled an unnecessary luxury a construction camp, but they have been tried out and proven a pa investment. Nothing is more sure to increase a man's self-respect to be clean and to know that he is in a position to keep so. A man a clean body and clean clothes has a personal interest in keeping surroundings clean and he feels in a fit condition to do a good work. Men work with greater energy if they can look forward to freshing shower bath at the end of a hard day's work.

A convenient arrangement for a bath house is a building 10 ft b ft. having a door at one end and partitioned off at the other so provide two small rooms about 5 ft. by 6 ft. equipped with show The two small rooms have a good, substantial floor of wood w slope sufficient to drain quickly. On the floor should be laid remov wooden racks or gratings on which the men stand. Every day wooden racks are taken up and thoroughly cleaned and the scrubbed by the camp man.

The showers consist of an 18-inch ring of ¾-in. perforated pipe a 1-in. steam pipe leading to the mixer. Taps or valves for both hot cold water are within easy reach along the wall, so that each man easily regulate the temperature of the water. A small bench or sto also placed in each room. The large room for dressing is sup with two radiators and two long benches. The building has a gable with a ventilator

A device in use in the British army may afford a suggestio cases where the water supply is scanty and the drainage condition poor. It is known as a "Russian Bath" and consists of a well structed tarpaulin hut into which steam is led and distributed by a forated pipe running along the floor. A 15-lb head raises the tem ature to 100 deg. in a few minutes. The bathers undress and ente hut, the moist heat causes profuse perspiration and the applicatio soap raises a good lather on their bodies. They then enter an ad ing room roofed by a grating onto which a bucket of cold wat thrown, which causes a spray that quickly removes all traces of lather. This device is quite efficient and it is readily seen that very water is used and the drainage problem is easily solved.

Laundry

A building to be used as a laundry in which men may wash clothes, will also be a good investment It should be a separate b ing similar to a tool or cement house, and supplied with hot and water, a half dozen tubs and a radiator in order that clothes ma dried indoors in winter.

Smoking

It is not necessary to make rules in regard to smoking, except men should not smoke in their bunks because of the danger from and that there should be no smoking in the bunk house after the li are put out at 9:00 P. M.

Intoxicants and Gambling

Intoxicating liquors should not be permitted around a camp in any form, and habitual drunkards should not be allowed on the work. Gambling should be strictly prohibited.

Recreation

Even though men are engaged in manual labor, they find rest in active sports such as boxing, wrestling, quoits, base ball, etc., and some provision for such can be made at little expense. For rainy days indoor games, such as checkers, dominoes, etc., will help pass the time agreeably, and books and papers are welcome at all times. At some camps musical instruments have either been provided or are owned by some of the men and do much to keep them entertained.

Military Camps

Much may be learned by noting what the U. S. Government is doing at its various cantonments and training camps in providing for the physical welfare of the soldiers. Modern army hygiene has been brought to an exact science which has had its most rapid development and perfection during the last twenty years. Should a soldier fall sick he is given the promptest and best of medical attention, and not only that, every possible precaution is taken to prevent the chance of development of disease or the spread of infection.

The following appeared recently in one of our daily newspapers and shows how thoroughly the subject of camp sanitation is outlined and carried out:

"Each large army area has not merely its regimental doctors and hospital surgeons and physicians, but a visiting sanitary inspector, with a staff of sanitary service men in each camp, who devote their entire time to inspecting and keeping up to the mark all the sanitary arrangements of the camps."

"In most camps every particle of refuse, of night soil, of garbage that cannot be utilized, is not only collected every morning with the most scrupulous care and cleanliness, but completely destroyed by burning, which ends at once all possibility of its ever getting into the water supply or fouling new camp sites or reappearing in any possible way to cause trouble in the future. All the manure from the horse lines, cavalry, artillery or transport, is either spread upon the land at once, often by the thrifty farmers of the neighborhood, or burned. This burning process calls for a good deal of trouble and skill, but it has another tremendous advantage in camp hygiene—that it robs our most intimate enemy and pest, the fly, of most of his hope of existence by depriving him of both pasturage and breeding grounds. This is supplemented by a vigorous anti-fly campaign, with the result that a large proportion of our camps on the western front are comparatively free from the plague of flies. This means that two-thirds of the risks of diarrhea and dysentery are wiped out at one stroke and accounts for a really astonishing scarcity of both these typical camp diseases."

It was the army doctors who discovered that typhoid was not alone the result of impure water, but that flies carry typhoid infection, that it may be contracted from eating contaminated food and that it may be spread by unwashed and unclean hands. The best safeguard against this is typhoid inoculation. Unclean hands are also liable to cause other troubles such as dysentery, cholera and other intestinal diseases. It is known that malaria is spread by one kind of mosquito and yellow fever by another. Swamps are being drained, ditches opened up, pools oiled and fish planted in waters where mosquitoes are apt to breed, and by these methods they are finally routed out.

Water cannot be used for drinking purposes until it has been ana-

lyzed and found safe by the medical officer. Dipping drinking w from pails or other containers is forbidden and all containers mus tightly covered as a protection against dust and other infection. W it is found necessary to use water that is contaminated or doubtf must first be sterilized, which is done with hypochloride of calcium

Kitchens and mess-halls are carefully screened and ceaseless fare is waged against the fly. Dishes and tableware must be prote from flies and dust. Dishes and cooking utensils must be cleaned hot water and clean towels. Ice-boxes must be frequently inspected cleaned. All food supplies are carefully inspected by sanitary off and the irresponsible vendor of foods is not permitted in the c The following foods are forbidden altogether—canned milk and ca fish opened the day before, hashes of meats and potatoes prepared day before, and green vegetables in localities where they are likel be contaminated.

The following personal requirements are insisted upon—bat least twice a week; hands washed before each meal; teeth bru once a day; underwear changed frequently; bedding and clothing su and tents aired daily, tents struck frequently to sun the sites.

General

It will be seen from the above that there are many factors ent into the management and operation of a camp. The physical fea are in a large measure controlled and modified by the nature of work and the camp, how long the job will last, the natural reso of the surrounding country as to food supply, the proximity of or city, and many others. It will pay in all cases to provide the with the best, within reason, that the circumstances will permit, out being extravagant or wasteful. Much will depend upon the att of the supervising force toward the workmen. Treat all of the whether skilled mechanics or common laborers, as men, let them that you appreciate their labors, win their respect and regard, get interested in the progress and success of the work, and you will done a great deal toward holding your forces together.

APPENDIX A

PUBLIC HEALTH REGULATIONS

The state commissioner of health of the State of Washington has prepa set of rules and regulations governing sanitary conditions in industrial c in that State. While similar regulations have been adopted in other State Washington rules are printed below because of the general interest in this su at the present time:

Washington Rules and Regulations

1. Hereafter contractors and all other persons who may establish an i trial camp or camps for the purpose of logging or any like industry or fo purpose of constructing any road, railroad or irrigation canal, or other requiring the maintenance of camps for men engaged in such work, or any temporary or permanent industrial camps of whatsoever nature, shall repo the state commissioner of health so as to maintain good sanitary conditions shall at all times keep such camp or camps in a sanitary condition satisfa to the state commissioner of health

2. The health officer of each county shall report to the state commissio health on the location and sanitary condition of all industrial or constru camps within his jurisdiction in the month of June each year, and at such times as the commissioner of health may require.

3. All contractors and other persons responsible for the control and agement and construction of industrial camps must use all reasonable pr tions to protect the men in their employ from disease, and to that end shall comply with the following regulations adopted by the state board of h

4. The following are the instructions and recommendations relative t proper sanitation of camps. The natural topography of the land where c must of necessity be located renders it impossible to specify in detail con plans for temporary camps, but the management of camps will be held st responsible for failure or refusal to comply with the general intent and spi these regulations.

(a) Camps must be established upon dry, well-drained ground.
(b) All natural sink holes or collections or pools of water must be drained and filled when the camp is first established.
(c) The stable and kitchen must be separated by a distance as great as consistent with the natural topography of the land upon which the camp is located.
(d) The toilets must be located convenient to the bunk houses, and as far removed from the kitchen and eating house as may be practicable.
(e) The use of toilets provided for the men must be made obligatory, and instant discharge of any employee polluting the soil in the camp must be rigidly enforced.
(f) In camps of 100 or over there must be one employee whose principal duty shall be to act as scavenger and garbage collector.
(g) All manure from the barns must be collected and burned at least once in each week. Instead of burning, the manure may be used as fertilizer on fields not less than one-half mile from camp.
(h) All toilets in the camp must be fly-proof. (The state board of health will furnish drawings of inexpensive fly-proof toilets upon request.)
(i) The kitchen and eating house must be effectively screened against flies.
(j) Garbage must be collected in tight cans and burned or buried daily. Garbage may be fed to pigs provided the pen is located not less than 100 ft. from the cook or eating house and kept in a sanitary condition.
(k) Tin cans and other non-inflammable refuse must be collected daily and burned over every ten days or buried in a pit.
(l) Food supplies must be carefully screened and thorough and systematic scrubbing of kitchen, eating houses and bunk houses must be observed.
(m) The supply of water for the camp must come from an absolutely uncontaminated source.
(n) Care must be taken not to pollute the water supply of another camp or the water supply of any of the people of the State of Washington.
(o) All sick from whatever cause should be isolated from the remainder of the crew immediately.
(p) All persons engaged in the care of the premises and handling of the food, particularly cooks and helpers, should be carefully examined and particular attention paid to the point as to whether or not they have suffered from typhoid fever within recent years.

APPENDIX B

ALASKAN RAILWAY REGULATIONS

Construction camps shall be located on the best site obtainable, from the standpoint of water supply, drainage and sewage disposal, consistent with convenience to work.

Water Supply

When the water supply is to be taken from a stream the point of intake shall be above the camp site, and a sanitary survey of such stream above such intake shall be made to ascertain if there be any source of pollution. If there be a source of pollution of such stream such fact, with all available data, must be reported at once to the sanitary officer of the division, by the district engineer, and a well dug to conform to the following regulations:

No well may be located less than 100 ft. from any cesspool, toilet or stable, and must not be on ground receiving drainage from any such place.

All wells supplied with pumps must be curbed up to a point one foot above the surface of the ground and tightly covered.

All wells supplied with ropes and buckets must be curbed up to a point 30 in. above the surface of the ground, and fitted with a good cover.

All wells must be backfilled with earth or gravel around the curb to a depth of one foot at the curb, sloping to the surface of the ground six feet away from such curb, in order that surface water cannot get into the well.

Cook Tent

The cook tent must be located on sloping ground or that which can be drained easily. The floor of such a cook tent shall be of dressed lumber, preferably tongue and grooved flooring, water-tight; if not water-tight, such floor shall be raised 12 in. above the surface of the ground so as to permit free circulation of air underneath; must be scrubbed daily and kept in a clean and sanitary condition at all times.

All fixtures and utensils must be so arranged as to permit of free access for cleaning purposes.

All work tables and other utensils must be kept free from accumulations, such as flour, dough, grease, etc.

All canned goods, excepting milk, must be emptied as soon as opened, and not permitted to stand in original tin cans.

All garbage should be burned in the cook stove as completely as possible.

Suitable fly-proof and water-tight cans must be provided into which all scraps, empty cans, and waste material shall be placed, which cans shall be removed to a point remote from camp, and the contents either buried or burned.

Such removal should be made every second day from May to September i[…] sive, and once a week during other months. Throwing such garbage in str[…] will not be permitted.

A well ventilated, properly screened fly proof meat house shall be pro[…] adjacent to the cook tent, for storing small quantities of fresh meat. On re[…] of any fresh meat in bad condition, from any cause whatever, such fact, with[…] data, must be reported at once to the district engineer, who will report […] to the sanitary officer at Anchorage.

Mess or Dining Tent

The mess or dining tent shall be separated from the cook tent or kitch[…] a door or fly that may be closed.

Tables shall be provided with cotton fly-screen, which shall be kept s[…] over the tables except when they are being used to serve meals. Mess tents […] be kept as free from flies as is possible, and suitable measures must be […] to secure such results.

DISCUSSION

F. E. Weise:—The matter that has been collected […] shows what should be provided in what might be called an i[…] camp. We cannot always reach an ideal camp, but wherev[…] is possible to provide the things that are spoken of they wi[…] found of advantage, because they will keep the men in a g[…] efficient condition.

A. Montzheimer:—I think the two papers that have […] presented this morning are always important, but to my […] they are more important now than ever before, on account o[…] great scarcity of labor. I don't think one point has been […] phasized sufficiently and that is the condition of the cars in w[…] the men are housed. Most railways provide the men with […] coaches and in some cases, with old box cars which are u[…] to handle in heavy tonnage trains, and there is a liability t[…] that may prove serious. On our road we have built steel u[…] frame cars in the last few years, especially for the men. T[…] cars are the ones the men are in when they are in the train o[…] road. The other cars hauling their tools are still of the old […]

R. C. Sattley:—I have just one suggestion on this las[…] per—that a first-aid outfit be supplied with every camp. O[…] cars used by the Government in the inspection of the railr[…] of the country for valuation purposes those kits are prov[…] In addition, I think there should be a Red Cross book in e[…] camp.

The President:—I think one of the most important sug[…] tions that has come up in this paper, and which has been […] spicuous by its absence in most of the boarding outfits, is tha[…] garding bathing facilities. It reminds me of a story of a little[…] whose mother sewed him up in his underclothes and sent hi[…] school. He had been going in a steam-heated schoolroom[…]

about a month. Finally the teacher didn't like his smell, so she sent him home with a note which said, "Give Jackie a bath and send him back." Jackie came back all right, and written across the bottom of the note the teacher had sent was scrawled, "Jackie isn't a rose—learn him—don't smell him." I think it is very important that there should be facilities in the boarding cars for the men to bathe during the winter, rather than to stay in their clothes until they don't resemble a rose.

J. E. Toohey:—The matter of keeping the bedding and the clothes of the men clean in the camp outfit is a serious matter with us. A year or so ago I devised a plan to wash them in a concrete mixer. We have a small gasoline-operated concrete mixer that is easily started. We heat the water with a steam pipe from a derrick car and the men wash the blankets once a month without any coaxing at all.

A. S. Markley:—Bridge and building men are away from their families more than any other class of men on a railroad. We cannot bring their work to them; they must go where it is. Consequently they are away from home nearly all the time, and we should make conditions as favorable and as comfortable for them as possible. We are gradually getting better outfits to house our men than formerly. In our camps they cook and eat in one car and sleep in a separate car, while we provide one combination car for the men to pass the evenings in, and one car to house the tools. The men are allowed to go home once a week, but they should have Saturday afternoon off to go home. If they go home Saturday night and return Monday morning they are not very energetic on Monday, after riding two nights. The office men get off in the summertime at 1 o'clock on Saturdays. Why not the bridge men?

It has been said that the gangs can board locally or at home. Some of our gangs have men from five or six different towns. We have to get them wherever we can. A man who don't want to go home to spend Sunday with his family is not the man we want to employ for best service.

In our bridge and carpenter gangs, where the men are employed steadily, they furnish their own bedding, stove and cooking utensils. They are furnished a cook who does the buying and cooking, takes care of the cars and does the clerical work.

Where we have a gang using common labor, such as a concrete gang, the foreman adds a couple cents on each meal to pay

for bedding, cooking utensils, etc. The fence men have same privileges as the bridge men. The company furnishes cook, and their meals cost them from 18 to 22 cents each. T cook, as a rule, has charge of the commissary and at the of the week each man's meals are pooled and the cost is t divided among the camp so that all the men fare alike on the c of living.

J. P. Wood:—I don't believe that it is a good policy have any set time that a man should stay on the work. I d practice it on my division, but I allow the men to go home o in two weeks, once in three weeks, or every night, as conditi permit. At the present time my entire force is working p tically 7 days in the week, owing to the material situation. material has been delayed and we are now trying to catch but nevertheless, whether we get the work done this year or the men are going home after they have been on the wor reasonable time. When we are working under normal conditi I tell my foremen to let the men go, especially the married n at intervals of not longer than two weeks, and just as ofte possible. I realize the situation that these men are in perh better than the men themselves, because I have been there know what it is to stay away from home anywhere from one to eight weeks. I love my home and so does the average n If he doesn't love his home tell the foreman to fire him. don't want him. You are better off without him, because eve ally he will be a disturber among the men. He will cause content. We have it, but we try, when we find those fellows to let them go quietly. We get rid of them.

W. F. Strouse:—The question has been raised as to the eral practice among the various railroads in regard to the pense of the board, and as to whether overtime is allowed on count of the men having to pay their own board. I would glad to hear some expression on that subject.

H. Bender:—I don't see why the men should be allo overtime because they have to pay their own board. T would have to pay it elsewhere. It seems to me that if were allowed their regular time, and overtime if they wor it would be sufficient.

S. C. Tanner:—On the territory of the Baltimore & C which I cover, I have tried to keep down the camp situatio much as possible and shorten up the territories so the men

get home whenever it is possible, without loss of time. We find it is more satisfactory, and we are able to hold the men together better. However, it is customary to furnish a cook in camps where we have to keep the men in them working a little overtime to make up for the lost time of the cook. The sanitary arrangements around the camps are important, but the most important thing of all in holding men is to allow them to get home as often as possible.

W. E. Alexander:—Mr. Pickering made some remarks about women cooks which I fully agree with. We tried that for some time on our road, having a man and his wife, who were good, efficient workers. The wife did the cooking and the man did the chores around the camp. He did this sometimes on his own time, as there was enough time and he got full wages for working outside and the wife got full wages for the cooking. That was very satisfactory, and as Mr. Pickering said, the morale of the men was better, the cars were more homelike; there were curtains on the windows, and little pictures on the wall, just like home. We had satisfactory service then, but it was easier to hold men at that time than it is now. Under the same conditions we no doubt would have a harder time to hold the men now. We have old coaches and old sleeping cars in our outfits. We have two old coaches, one fitted for a living car, and one for a dining and cooking car, and then we have a tool car (a strong box car that is probably out of date for the best service), and a flat car to carry the material. It requires four cars for the crew. The cars are not strong, hence they are placed in the rear of the train.

The President:—I want to say as to the question of women cooks, this country is a pretty big country and standards of morals are different in different parts of the country. Having spent the first 23 years of my life in the East and the last 17 years in the West, I have seen the contrast. Just within the last week my brother and his wife moved from Boston to St. Louis. They went to a boarding house there while looking for permanent quarters, and she has been horrified at many things that to some of us in the West seem entirely proper.

Now on a good many of the railroads in the West they have had women cooks in the past, and as a result of some such experience as Mr. Alexander has reported, the women cooks have been ruled out of line. Perhaps the trouble, or part of it, out here is that the younger men get to be foremen, while in the East

the men are older before they get to be foremen; their w
are mothers maybe, and they are absolutely above repr
Now if some foreman has young ideas and marries a young
she would be the wrong kind of a woman to have on the boar
outfit in the West. A young woman has no place whateve
the boarding car. The older men with their wives are the or
they add a touch of home, and keep the men where they o
wise could not be kept. In each case the personality, the
acter and the age of the woman should be considered, and w
that is done I think it is a very good thing to get women o
and it will add to the efficiency of the gang in every case.

SNOWSHEDS

By Geo. W. Rear

General Bridge Inspector, Southern Pacific, San Francisco, Cal.

Few members of the Association have snowsheds to maintain and it may be well at the outset to say that those who have not are not missing much. They are not an attraction in any way, being far from ornamental and are in most ways a genuine nuisance. Such being the case, there must be some cause for their existence. There is such a reason—they keep the snow off the track.

It will be noticed that these sheds are used only in the mountains in the western part of Canada and the United States, and investigation shows that in these mountains there is the greatest known annual snow-fall, especially in central California where the Southern Pacific crosses the Sierra Nevada mountains. The following figures show the annual snow-fall at various points along the line and the photographs give an idea of what the country looks like when covered with snow.

Station	Elevation	No. Years Record	Average Seasonal Snowfall
Blue Canyon	4695 ft.	14	17 ft. 3 in.
Cisco	5939 "	33	30 " 10 "
Emigrant Gap	5230 "	29	23 " 7 "
Summit	7017 "	44	35 " 0 "
Truckee	5819 "	35	16 " 0 "

Truckee is at the eastern base of the range and gets less snow-fall than stations at the same elevation on the western slope. This is due to the fact that the clouds move easterly from the Pacific coast and drop their moisture before getting over the range. The moisture is deposited in the form of rain to an elevation of about 3500 ft., snow seldom extending below that height in this latitude. The maximum snow-fall at Summit occurred in 1879-80 in which year $65\frac{1}{4}$ ft. fell, but this record was nearly reached again in 1890 when $64\frac{2}{3}$ ft. fell.

This snow falls in a period of about three months and very little goes off during the winter, although it keeps settling down until the average depth on the level is about 15 ft., although 26 ft. has been measured on the level many times. This makes the snow very heavy, with streaks of ice in it, and it is hard to handle with plows. Rotary plows are used in the territory at each end of the sheds where the snow-fall is less. On certain slopes and in certain canyons the snow piles up to great heights, well onto 100 ft. deep.

The snowsheds in this territory are built of wood and are of two general types: (1) Those designed to keep snow off the track only. (2) Those designed to convey snow and snow-slides over the track. There are 30 miles of these sheds in all, covering a territory of about 40 miles, there being some breaks near the lower ends where the snow-fall is less and where sheds are used in cuts only.

The first sheds were built in 1868, the frames being constructed of round timber cut alongside the track and the sheathing being cut in neighboring sawmills. They are of the pitch roof type as shown in the diagrams. They had the fault of crowding out of line when unevenly loaded with snow and were extremely hard to restore to line. It will be noted that the vertical clearance was only 17 ft. in 1868 but this

In the longer stretches of the sheds, telescoping sections 100 ft. long are built as often as feasible. These sections are mounted on wheels and are rolled back into enlarged sections of the adjacent shed during the summer, making a break of 100 ft. These telescopes divide the sheds into short pieces, so that no great length is liable to burn at one time. It should be understood that a fire in these sheds burns the track ties and ties the rail in knots, destroying not only the shed but the track, so the fire losses are more serious than the actual value of the sheds alone would indicate.

To detect fires, a system of patrol is maintained, each patrolman reporting at an alarm box every hour. These alarm boxes are a little less than a mile apart and each report is registered automatically on a tape which is under constant observation at Summit station and is duplicated in the roadmaster's office at Truckee. When an alarm is rung in, the nearest fire train is notified and the main line is cleared of traffic. (The line is single track but, with sidings every two miles, little time is

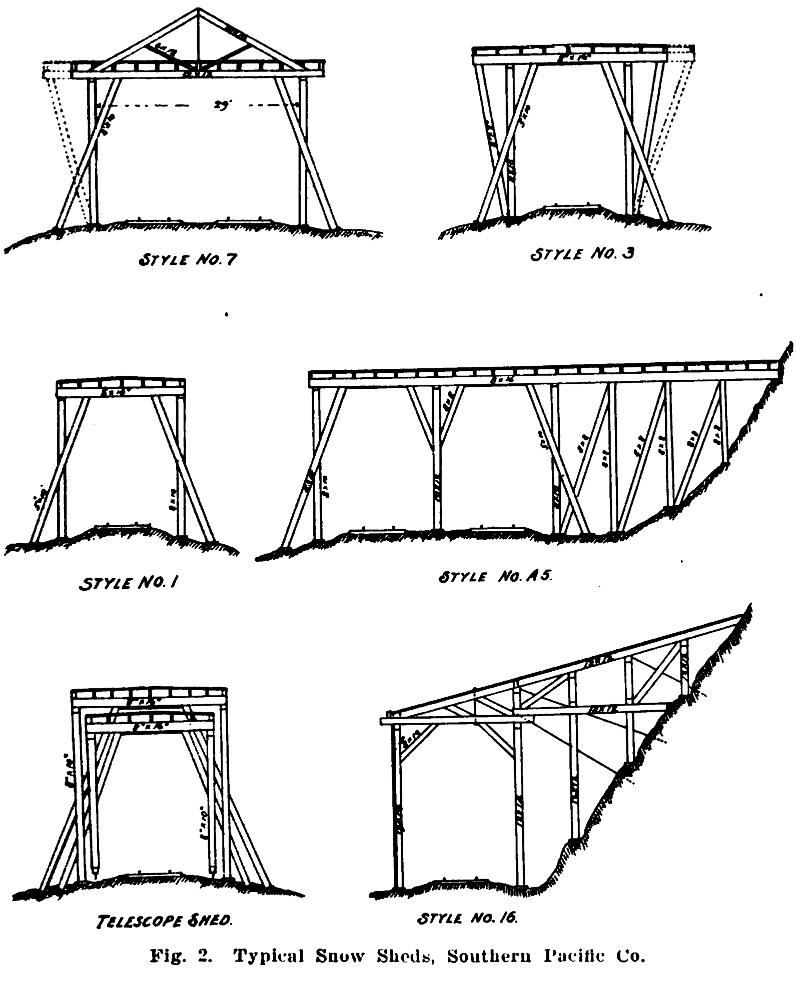


Fig. 2. Typical Snow Sheds, Southern Pacific Co.

though slides occur at unexpected places and it is on these occasions that the merit of the wooden sheds is appreciated. When the entanglement of snow, brush, boulders and sheds is observed, one wonders how the situation could be handled if concrete and steel were also mixed with it. Notwithstanding this, there is no doubt but that concrete sheds will be used in this locality in the near future.

The Union Pacific is building some concrete snow sheds in Wyoming, but conditions are different in that locality. Their trouble is from drifting snow which, in its travels across the plains gathers up so much sand that when it fills the cuts it is nearly 50 per cent sand and ordinary snow-handling apparatus is nearly useless. An illustration of their shed is shown in Fig. 3, page 170.

Sheds are also used in Washington and British Columbia and are of a very much heavier type as they are intended to retain the sliding hills as well as the sliding snow, but the writer has been unable to get any plans of them.

It is believed that the plans and photographs attached will give a better idea of the appearance of the sheds than a written description.

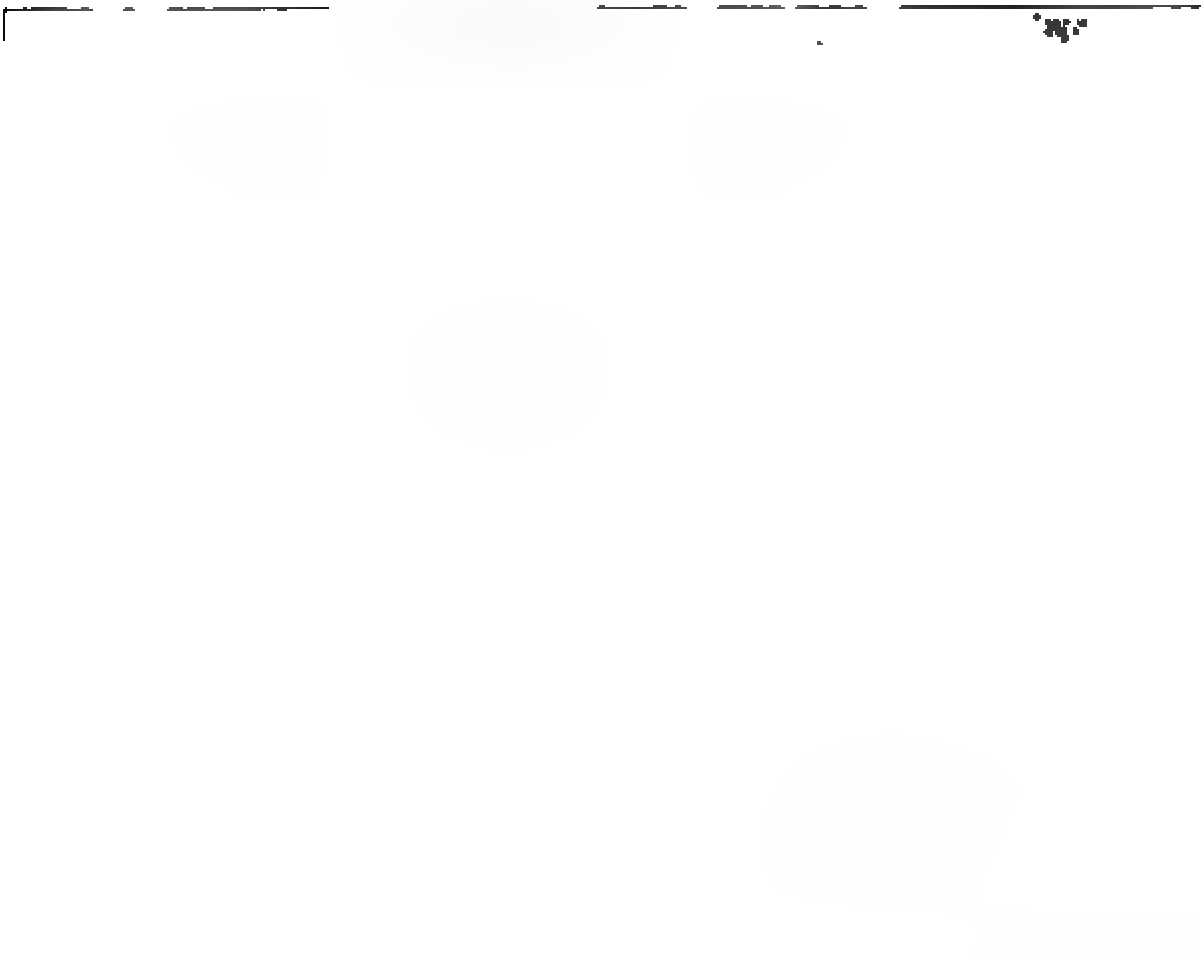


Fig. 4. Rotary Snow Plow

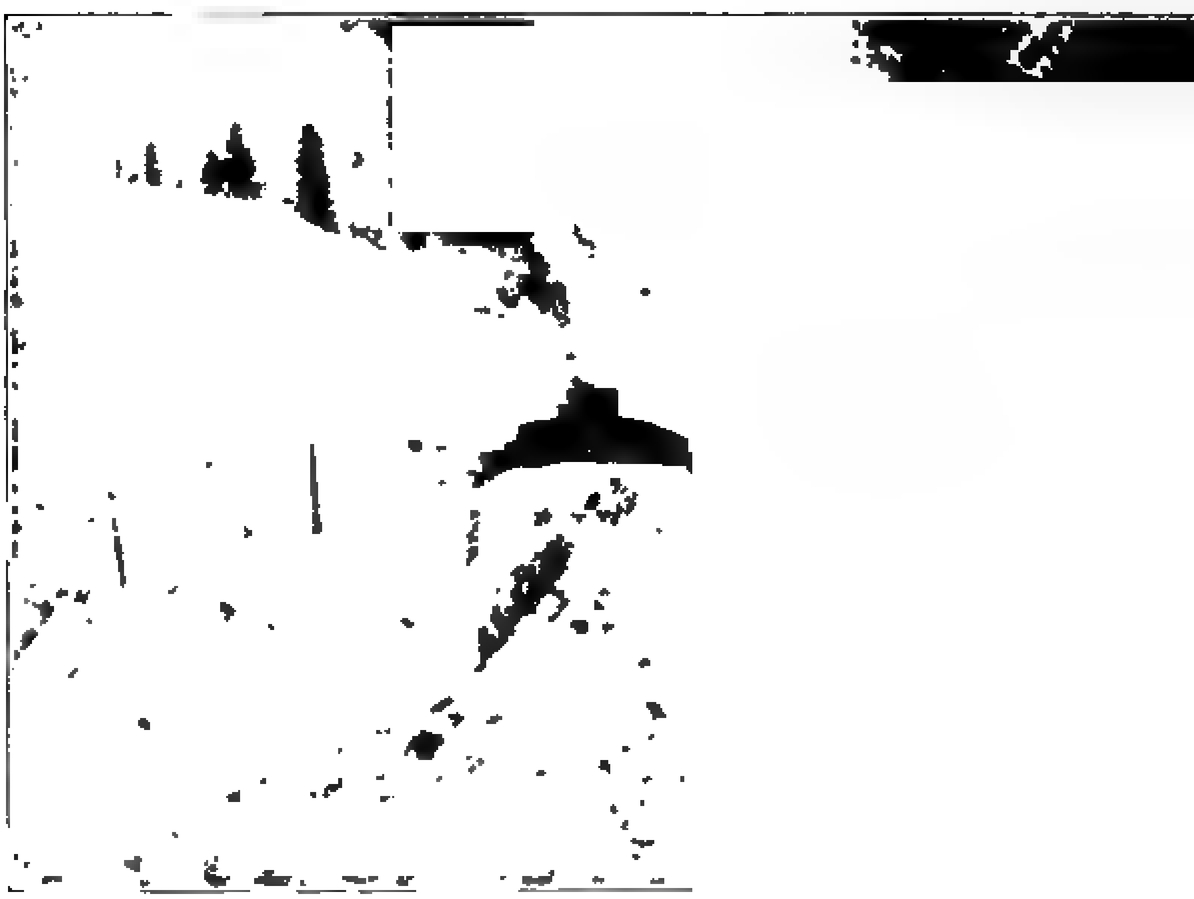


Fig. 5. Rotary Snow Plow in Action

Fig. 6. Entrance to Snow Shed, Southern Pacific Co.

Fig. 7

Fig. 8. Snow Covered Sheds, Southern Pacific Co.

FIREPROOFING ROOFS OF WOODEN BUILDINGS

COMMITTEE REPORT

This subject will be considered only with reference to the fire-resisting qualities of various solutions, coatings and coverings which have properties capable of withstanding fire coming in contact from without. Tile and other cumbersome materials not suitable for wooden buildings will not be considered.

Wooden shingles were used almost universally in the earlier days of railroads for the covering of all ordinary buildings having roofs with a pitch greater than one-fourth, and while they are rapidly losing favor there are certain localities where they will be used for some time to come owing to their moderate cost, light weight, low heat conductivity, wide application and durability. When shingles get old they become a considerable fire risk and are set on fire readily by sparks from passing locomotives. While there are a number of preparations on the market for making them fire-resisting to a considerable degree they are likely to be negelected beyond the length of time the preparation remains effective and the roof thus again becomes a fire risk.

In making wooden shingles fire resistant, Henry A. Gardner, assistant director of the Institute of Industrial Research, Washington, D. C., in a paper read before the 1914 convention of the Master House Painters and Decorators' Association of Pennsylvania, stated in part as follows: "At various times there have been placed upon the market fire-retarding solutions which have had more or less merit for the individual purpose. They consisted usually of water solutions of various salts, which, when applied to canvas, scenery, or like materials, would dry and leave the material coated or impregnated with a quantity of the dried salts used in making the preparations. In treating wood or cloth with such salts, it was generally found necessary to apply several coats of the solution, sometimes as high as six or eight, in order to get satisfactory results." After naming a variety of compounds that are commonly used Mr. Gardner stated that sodium chloride (common salt) is one of the cheapest mineral salts and quite as effective as many of the others.

From the book entitled "Fire Prevention and Fire Protection" by Freitag (John Wiley & Sons, publishers), pages 838 and 839, we quote in part: "So-called fireproof paints or cold-water compounds which are sold under a variety of trade names, all claiming fire-resisting properties, should be classed as fire-retardants rather than as fireproof. While wood or other combustible materials which have been coated with such compounds will withstand the blaze of a match successfully, a few minutes' exposure to a greater heat, as of a lamp, will show that no great degree of fire-resistance exists. However, the preventive value of such coatings is material, especially for scenery, properties, and other stage fittings, that the quick spread or 'flash' of fire over such materials will be greatly retarded, if not prevented altogether. The use of fire-retarding paints or solutions is, therefore, to be strongly recommended for scenery, etc., whether required by law or not."

Believing that it was the intention that this report should give more consideration to coverings which are in competition with the wooden shingle we will proceed in that direction.

Coverings prepared by saturating felt with asphalt, sometimes termed "composition roofings" or "prepared roofings" are sufficiently fire-resisting for all practical purposes, and on buildings which have a pitch of one-fourth or greater and where appearance need not be taken

into consideration, such material laid from rolls in large sheets w
2-in lap joints may answer the purpose as well as anything. These rea
roofings are also put up in the form of shingles, which, if properly la
make a very good appearance and will last from 6 to 15 years, deper
ing on the quality of the materials used in their composition. T
trouble with the ready roofings is that, when the oil dries out of
asphalt, the felt becomes dry and brittle and the life of the cover
is at its end.

Most wooden buildings with flat roofs or roofs with a slight pi
are best covered with tar and gravel or metal, the former being gen
ally used on main buildings and tin in sheets on porch roofs and ot
places where tar and gravel would be objectionable.

Shingles made from a composition of cement, asbestos, etc., a
having various trade names, are used to a considerable extent and th
present a good appearance These have not been in extensive use lo
enough to determine how long they will last, but up to the present ti
they seem to be a good substitute for slate and are not as easily brok
They have been in general use only from 5 to 10 years.

Slate shingles have been in use for many years and for roofs h
ing more than a moderate pitch they are perhaps as durable as a
thing on the market, or much more so. In cold climates where
pitch of a slate roof is less than one-third or one-fourth slate of
proves troublesome, as, where heat from beneath melts snow which
lodged on the roof, it holds the water in suspension while it finds
way under the slate by capillary attraction and if freezing occurs bef
the water runs off it invariably breaks the slate shingles in great nu
bers. This will cause a leaky roof, or the roof may leak under th
conditions without the slate being broken if the felt undercovering d
not give the required protection This melting and freezing condit
is quite common where the roof continues from a warm building
broad eaves or sheds where it is cold underneath and more especia
if there is a break in the pitch of the roof at the eaves.

Tin shingles are used to a considerable extent on some roads a
give good satisfaction. When secured with the "bar lock" it is
possible for a tin roof to leak during its lifetime These shingles
manufactured in various ornamental styles and make a neater appe
ance than any other kind of ordinary metal covering. Their life
railroad buildings depends entirely on the kind of metal and its p
tective coatings,—tin, galvanizing, paint, etc.

Galvanized iron, laid in sheets with seams running vertically,
been used to a considerable extent and will last a long time if pain
about every three years but it does not present as good an appeara
as ornamental tin shingles. These metal coverings are not nearly
durable as they were when wrought iron and old style tin were us
Tin or galvanized iron with soldered seams is often used on flat ro
and will last a long time if properly protected with paint.

The ordinary tar and gravel roof is probably more extensively u
on roofs having a slight pitch than any other kind of covering and
wearing qualities are so well known as to require little comment
life depends solely on the quality of the materials used and their ap
cation.

Roof coverings which require protective coatings are at a deci
disadvantage for the reason that they are liable to be neglected
yond the time when the coating remains effective when the cover
suffers and may result in premature loss.

C. A. Lichty,
J. B. Gaut,
A. T. Hawk,
J. W. Miller,
P. Aagaard,
Committee.

DISCUSSION.

The President:—We have here to-day one of our members, a consulting timber engineer from St. Louis. I think Dr. von Schrenk knows more about timber than any other man I have ever met, and I would like to hear from him because I believe he has something to present to the association at this time.

H. von Schrenk:—What I heard this afternoon about the poor wooden shingle put me in a combative frame of mind. It reminds me of a story of a doctor on a train who went into the washroom and, seeing things lying around in a rather disorderly state, he began a tirade on the bacteria and the carelessness of people. Looking around he beheld the negro porter standing there with his brush, ready to brush him off. The doctor said, " There is one of the chief evils of the day." The negro heard him and he said, " Well, doctor, what little brushing I'se going to do to you fellows won't do you much hurt."

I want to comment briefly on the report of the committee, which I thoroughly approve of except for one paragraph, in which the chairman said they are going to consider the materials which are replacing wooden shingles as coverings. I don't quite like the exact language used. I would suggest that that possibly be changed or modified to substitute for the word "replace," the clause, "the materials which are in competition with wooden shingles."

I want to take a very few minutes of your time to present to you the preliminary results of an investigation we have been conducting for ten years in relation to the fire hazard of the wooden shingles. We started this 10 years ago with investigations in London and Berlin in an attempt to find some techical method of determining the fire-resistant qualities of different woods, but very few methods have been developed by which the ordinary man could tell from the thousand and one things offered to him which would be the most effective as a preventative of fire.

We are all familiar with the usual methods of testing different materials, of holding up a particular object and holding fire to it to see if it will burn. But all of those methods are subject to criticism, or, it might be said that they are not comparative tests, because in no two cases do you make the attempt in exactly the same way.

The first thing we tried to do was to formulate a metho which the ordinary person could determine the fire-resis qualities of building materials. We started with the roof erings, of course, because we thought they presented the h est degree of fire hazard. There ought to be no question am good, conscientious citizens but that an unprotected woo shingle should not be used in a position where the hazard i high. But the high qualities of the shingle, its availabilit you can get them all over the country,—and its low cost, have made it so acceptable as a building material that the p lic is going to use it for a good many years to come, in s of its one defect.

Our problem was to overcome that defect. I have brou here with me to-day some sample roof sections which tell story much better than anything I can possibly explain to y With the coöperation of the National Paint Manufacturers' sociation we finally developed a paint which sells for consi ably less than the high grade lead and zinc paint, and whic composed of about 50 per cent asbestine, the pigments mak it a red, slate colored, gray, or tan paint which is applied a priming coat first of all by dipping the shingles into it. prospect is, at the present time, that this will be done at point of origin, so that the shingles will already be dipped w you buy them. Then when they are put on the roof anot coat is applied.

We have constructed a number of these small shingle de which are placed at the end of a long box, through which cause air to go at a velocity of three, four or five miles an ho Then we put on a brand. We made a lot of experiments to termine the kind of wood the brand was to be, and we fina decided upon white oak. This brand is ignited and placed up that deck, and we had to make it so large that it would variably burn up an untreated roof, because it had to be sev enough to burn up the brand used in making the experiment.

I realize the weight of that brand is probably greater th that of brands which usually give rise to conflagrations, but experiments which we made were conducted by members the Government and before eminent engineers, and they seemed to think that the test was not too severe.

The untreated roof will burn up in 15 or 20 min. if allow to continue, but in 99 cases out of 100 on the painted roof t

fire will go out after the brand has burned out. Without trying to make invidious comparisons, I have put on the table a series of fires which have been classed as the fault of the roofs, not to show that some of those roofs are not good, but simply to show the relative degree of resistance between the many prepared shingles and the asphalt, for instance. The asphalt shingle, in nine cases out of ten, will burn through.

We are putting out hundreds of large test decks at our laboratories in St. Louis for the purpose of exposing them to fire and to determine the relative resistance of certain materials we are going to make tests of. Those tests will all be made in our own furnace or in the Underwriters' Laboratories in Chicago. We are furthermore putting out several hundred smaller test sections. They will be burned every few months.

I have also put upon the table a rather interesting paint which we became interested in, largely through the demand which the Government has lately made in connection with the construction of the large warehouses and cantonments all over the United States, with reference to painting the interiors of the buildings. I thought you might be interested in trying out paint of that sort, particularly the white paint which I have put there. Of course, that is not the only paint. There are a number of different kinds offered for sale over the country which have a tremendous degree of fire resistance. Ordinary Government whitewash is one of them, although it is not so good as some others.

Those compounds, of course, are unfit for the roof covering, because the primal requirement for a roof covering is a fire-retarding quality. It must be cheap and it must not contaminate the water which runs off the roof. But one advantage of that is its high degree of permanency. Five years is a safe period for the exposing of that paint. From all the shingles I have examined on the roof, I am convinced that the painted shingle never curves, thereby materially reducing that hazard which comes up with the unpainted shingle. That is another point in favor of the painted shingle.

While I am on my feet I want to express my appreciation to the committee on paint in connection with the way they have carried out the idea of the primer coat. We have discovered that the chemical formula of paint has practically nothing to do with its adhering qualities or the lasting power of the paint.

The great factor is in the care of the priming coat. I he agree with Mr. Ettinger that instead of covering the bui with one heavy coat of paint, I would rather go over it times, because the sticking capacity, where care has been in the principles of the priming coat, is so patent that it sh be known to everyone.

The Secretary:—Mr. President, I believe that all our bers will agree with me that Dr. von Schrenk knows he is talking about or he wouldn't be employed by the Go ment in making some of these tests. The committee will r its report to make it agree with the tests which he has to s as far as they bear upon this report. There is no doubt that a wooden shingle, if handled rightly in the first place be made sufficiently fire-resistant to withstand the ordi fire test.

P. J. O'Neill:—It seems to me that we are confronted the old question of theory versus practice. Dr. von Sch tells us they are going to furnish us a way that is different the proper way to apply paint is "a strong arm on a brush." The way to get the paint on to stay is to rub it on. have abandoned the practice of painting wooden roofs on New York Central because in applying the paint to the ro little dam forms along the base of the shingles that retards water, causing it to soak into the shingle. In a few years rot off. I consider the old method of painting the roof is a d ment to it.

UNIFORM VERSUS DIFFERENTIAL RATES FOR BRIDGE AND BUILDING DEPARTMENT EMPLOYEES

By E. T. Howson
Editor, Railway Maintenance Engineer, Chicago, Ill.

The bridge and building department in common with other branches of the maintenance of way department, is experiencing serious difficulty at present in retaining adequate forces. The competition for men has become unusually keen, particularly since July 1 of this year when the construction of the cantonments and other concentration camps for military forces called for large numbers of carpenters and other skilled mechanics at wages far above those which the railroads were paying. However, in spite of its present acuteness this problem is not entirely a recent one, but it has been developing for many years. The present abnormal conditions are only revealing more prominently the fact that at each recurring period of prosperity, the railroads lose their men to other industries, which indicates that they are not meeting the competition of other employers successfully. Primarily this is a question of wages and this fact leads to a consideration of the present basis of wage rates on the railroads.

The principle upon which wages in the maintenance of way department are based is that of a flat or uniform rate for every man. This in turn presupposes that all men are worth equal amounts or that they are of equal ability and efficiency. It is primarily because of this foundation that difficulty has arisen in retaining forces, for when a man realizes that increased experience and greater effort are not rewarded, he either reduces his pace to that of the rest of the gang or, if ambitious, he goes to another industry where his efforts are more adequately rewarded. In either case, the company loses the benefit of his greater exertion.

Furthermore the railways have not kept pace in the last few years with the rapid increase in the wages of skilled workmen in other industries. In many cases it has been considered impractical to raise the wages of the large numbers of men employed because of the expense involved, while in others the disinclination to disturb relations with the wages of other employees has tended to hold all of them stationary. The result has been that the outside industries have been able, through their higher wages, to attract the best men, leaving the less efficient to the roads.

All of these conditions have acted to the detriment of the bridge and building department and have affected the efficiency of the forces adversely. In view of the present almost universal shortage of men, it is, therefore, particularly important at present to consider ways in which this tendency can be arrested.

One suggestion which has been made to meet this condition is that of establishing different rates for the men in the gangs, which rates could be so arranged that while the total payroll for the gang would not be increased, the men would be paid in proportion to their experience. In other words, instead of paying a flat rate of perhaps 30 cents per hour for all men in a gang, good, bad and indifferent, experienced and inexperienced, a few men might be paid 35 cents or 40 cents per hour, others less experienced, 30 cents, and the remainder of the gang

would be composed of ordinary laborers, who would be paid the vailing laborers' rate of perhaps 25 cents. In this way, it would be sible to retain a nucleus of efficient men in each gang as their w would compare favorably with those in competing industries. T men should set the pace for the entire gang including the lab who should be little, if any, less efficient than the inexperienced now composing the larger part of the forces in nearly every gang graduated rate can also be held out to the newer men in the gang reward for experience and as an incentive for them to put forth best efforts. In other words, the tendency of such a plan is to both the inexperienced and the experienced men, a thing much t desired.

One objection to this system which has very largely retarde adoption is the fact that the establishment of a higher rate for group of men disturbs relations with other groups. Regardles the merits of the contention of any group of employees, the raisin their rates enables other groups to argue that their work is as im tant relatively and that they are also entitled to increased pay a is very difficult to refute such arguments.

An even more serious objection to the differential rate is the dency of some foremen and not a few supervisors to use such a d ential as a means of securing higher wages for as many of their as possible without regard to their merit or the purpose of the d ential. If this plan is admnistered in such a way the only result increase the payroll without securing a corresponding return and plan defeats itself.

In spite of these handicaps a differential wage rate adjusted t merits of the different classes of employes has much to commen particularly at the present time when labor is so scarce and so nom If fairly and intelligently administered, it will benefit a road by ena it to meet the competition of industries to a greater extent than is possible, while it holds out the promise of reward to the younger less experienced but ambitious workmen.

This is not an untried theory for at least one road. The St. L San Francisco adopted the plan of paying differential rates for its br building, painting and concrete forces over a year ago with exce results. The most experienced carpenters and painters are now 35 cents per hour A second rate of 30 cents per hour is paid for efficient men while general handy men are paid 27½ cents and lab from 15 cents to 25 cents, depending upon the locality. These have enabled the road to secure and hold a much better class of than formerly and as a result more work has been done by this f this year than in any similar period in the history of the road. The cers in charge of this branch of maintenance work state that if plan had not been in effect, much of this work now completed w have had to be left undone because of lack of forces. The stateme further made that this plan has been shown to be economical to the r

As an instance of the manner in which the men regard this me of payment, the Frisco sent a gang of 50 men to Fort Sill this sum where the government was hiring every man it could at rates al twice those being paid by the road. In spite of this fact, the road not lose a single man from the gang, although it contained som the best carpenters in its employ.

DISCUSSION

E. T. Howson:—It seems to me from the discussion morning that the idea of the program committee that we sp a half day on the consideration of the labor situation has b

vindicated by the information brought out. Every man I have talked with seems to be up against it for labor. It is a universal complaint. But I believe the present labor shortage is going to be a blessing in disguise to the roads, and the bridge and building men primarily because it is focusing attention upon one of the sore spots in maintenance operations and is going to bring about reforms that are going to be of permanent benefit after this shortage has disappeared. Also, I think it is going to be well for us to prepare for a shortage of labor for several years. I think it will be indefinite,—we can't say how long. The war will close, but the Alien Labor Law and other conditions are shutting off the immigration of large numbers of men into this country and that is going to create a shortage in all branches. It may not affect the bridge men immediately but it will ultimately.

A man asked me the other day what I thought were the essential elements in the solution of the labor problem, and I listed three things,—Adequate Wages; Permanency of Employment, and Good Living Conditions. It seems to me that the other defects hinge around those three. We have spent a large part of the morning very properly upon living conditions, but there are other phases, one of which is the wage situation, and just one angle of that is treated in this paper.

One very important consideration in this labor situation that this plan of increasing rates for length of service tends to improve is the labor turn-over. Every one realizes that it costs a lot of money to train a man. The present practice is to train the men for a contractor to take when they become skilled. The road assumes the expense of developing a man into a semi-efficient workman and is then unable to hold him in competition with other industries. Some of the factories figure it costs from $75 to $200 to train a man into an efficient employee. I don't know of any railroad that has ever endeavored to arrive at the cost of training a man to be an efficient carpenter, but the cost is there just the same. The continual changing of forces is one of the most expensive features of maintenance work.

An officer of the Pennsylvania Railroad read a paper at the National Safety Conference in New York recently in which he gave some figures on the cost of turn-over. This road employs about 450,000 men in the maintenance of way department, and 400,000 of them are new every year. The average length of service of the maintenance of way employee is about 13 months.

The President:—I don't know how many of you gentlemen have given thought and consideration to the so-called Differential Rate and Sliding Scale of Wages, but I think it a very important matter and that it ought to be followed out in many lines, and I think it can be well applied in the bridge and building department. There is no reason why a certain fixed rate should be paid to a man in the first year and the same in the fifth and the same in the tenth year, and the only hope of a man getting away from it is that he might get to be a foreman and be put on a different arbitrary rate.

There should be a sliding scale extending over so many years, by means of which at the end of every year a man would have an increase of one cent, we might say, and at the end of two years, an increase of two cents, and so on. A man in service 10 years would be getting 10 cents an hour more than the man who was just starting, and that would go far toward making the men satisfied and keeping them from unionizing. The higher wage men, who have been in service the longest, the older men, would not be interested in any agitators that might talk to them. Some of the younger men might, but the older men would stay, and you could get along without the younger men and get others to take their places. I think one of the things that should be given more consideration than it has been given in the past, is the Sliding Scale of Wages.

The line that I think of now where it is being followed to the greatest extent is among the motormen and conductors on street railways in almost every city and street railway in the United States. They start on a fixed rate, the next year they get a little more, and the next a little more than the last, and some of them increase up to the 15th year. It is remarkable to compare the seniority list of roads which have the sliding scale with the seniority list of roads which have a flat rate. Those roads which have the flat rate have a lot of men working for them only a few months, whereas the roads employing the sliding scale have had a lot of their men with them over a period of eight or ten years.

F. L. Burrell:—We have tried the sliding scale on our division for six or seven years, and we find it an advantage.

Once in a while a man will say he has to have more pay. As I look at it, the way to handle those cases is the way I handled that of a man who came to me and said, "I have been getting 30 cents an hour, and if you can not give me 35 I am go-

ing to quit." "Well," I said, "let's go in the office and talk it over." When we were in the office I said, "I want to tell you something. I have tried you out. I have sent you out to do work and you have not fulfilled my expectations. Now if I send you out with a foreman getting $100 a month and you can't do the work after you have had a year or two of experience, do you think you are entitled to 35 cents?" "Yes," he said, "I do" "Well," I said, "let's put it another way. Suppose you employ me and you are paying the money out. If you found I could not go out and do an ordinary piece of work after two years' experience with a man with you to show you how, who was getting $100 a month, would you consider that I was being treated fairly or unfairly?" "Oh," he said, "I wouldn't want to pay you any more." "Well," I said, " you go to work again." He went to work again and he stayed. I believe we can talk to these men individually and get results.

G. W. Andrews:—The Baltimore & Ohio adopted the sliding scale or differential rate 15 years ago, and as a whole has found it very satisfactory. There have been exceptional cases, as you will find under all conditions, where some of the employing officers find that they can get a good man and have employed him at the higher rate. In some cases that has caused dissatisfaction among those getting the lower rate. However, as a whole, the tendency has been to raise the man from the lower rate gradually to the higher rate, and we have today a number of men getting the higher rate whom we employed at the lower labor rate 10 or 15 years ago. They understood that an increase in their salary depended almost entirely upon their own energy and ambition, and they have looked at it in the right light. I feel safe in saying,—and I believe our master carpenter will bear me out,—that a great many of these men today are the most valuable men we have.

A great many young men coming on now can not understand why, if they are holding up their end of the work, they should not get the same wage as the other man does, but when the matter is explained to them fully and clearly, most invariably it brings about the proper results. It isn't difficult to explain his lack of efficiency and his lack of knowledge and experience to the ordinary man, and when that is done and he is beginning to feel that it will come to him just as soon as he proves himself capable, he starts in with the determination to

win. We have among our best master carpenters, a man who started in as a laborer, at a laborer's rate, and soon developed into an efficient carpenter, a leader of the gang, a foreman, and later a master carpenter. Personally, I believe as a whole that the differential or sliding rate has been not only successful but fairly efficient.

A. S. Markley:—Is there a limit to the highest wages paid, or the number of men who shall receive the higher wage, or will they all come up eventually?

G. W. Andrews:—The manner in which we started it was to state that a certain number of the men in the gang, being leading men, would get the higher or maximum rate; a certain number would get the middle rate and a certain number the lower or minimum rate. The higher rate was a considerable advance over the ordinary laborer's rate paid, and the men were selected as a rule from those who had been employed as laborers. That left only a certain number who could be advanced to the higher rate, but that is being remedied by giving authority to increase the men to higher rates when they prove that the company is justified in paying that rate.

We are now, like everybody else, laboring under the greatest difficulties, in retaining men at any rate that the company feels capable of paying.

The President:—I would say, in reply to Mr. Markley's request, that in asking whether or not the number of men getting any particular rate should be limited, where the sliding scale on a seniority basis has been adopted, where the men get a certain rate the first year and a higher rate the second, etc.,—there has been no limit to the number, for the reason that the companies have presumably thought it would benefit them in order to get more of the older men into it.

L. D. Hadwen:—I concur very heartily with Mr. Howson in thinking that the differential rate is one of the best means of building up a sound organization in crews of any kind. There is one feature that he did not mention that I would like to emphasize, and that is, we should not consider one rate fixed by the conditions in one locality as an excuse for the same rate being used on a different section of the division or a different portion of the system for similar work, where labor conditions may be very much easier. I think that fact should be borne in mind in considering the question of rates. We, in our construction work,

are permitted a certain amount of leeway in fixing the rates in the crews, and my experience has been that there is nothing more helpful than having the men know that their worth will be appreciated, that they will have opportunities for advancement, and that the man who is more efficient will receive a higher wage than the one who is merely a laborer, working from day to day.

E. T. Howson:—A large part of our troubles with labor at present have arisen because we are using antiquated methods of 20, 25 or 30 years ago. Labor conditions have changed. Men have become much more scarce and we are now confronted with a different situation than we were years ago when we could get all the men we wanted. Now the men are in demand, and we have got to consider that they are men. We have got to handle them in the same way. A man is looking for some method of advancement, and, as a matter of fact, the man who isn't looking for advancement is not a good man to have in the gang. We should not expect a man to live under conditions in which we would not live. The men in the gangs are "men," and should be treated as such. We have got to give them conditions that will appeal to them the same as to you or to me, and when we reach them on that basis, it will go a long way toward solving the problems.

In many instances the higher priced man is the cheaper man. It requires supervision to see that the foreman does not ask for higher wages for everybody, however.

I think we are going to come to the point where we are going to use fewer men and a better grade of men. The railroads have been particularly extravagant in the use of men. They have not been up to the standards of other industries, but they have got to come to the use of more labor saving equipment.

J. B. Sheldon:—The railroad with which I am connected has a maximum wage for the highest grade men. It has been my practice for a good part of a century to grade the men, as far as I could, under the conditions in which they worked. I have taken the young, inexperienced man from the farm or the shop, and increased his wages as he developed in skill. We are handicapped, perhaps, by having a maximum wage, but it has worked out very nicely. As a result, I have men who have been with me for more than 25 years. Many of them who started at the

bottom have developed into our most efficient men, and we have scores of them who have been with us 10 or 15 years. The sliding scale gives us a chance to hold the men and keep them satisfied.

That sliding scale has been interrupted somewhat in the last year or two on account of the labor situation, because we are unable to get anybody to do anything for less than the maximum wage. That has had its disrupting effect on the older men: but as a general proposition the sliding scale or the differential rate is founded on solid business principles and will give the best results all round.

B. F. Pickering:—I heartily concur with what has been said with regard to the differential rate. It is a well-known fact among all supervisors and superintendents of bridges and buildings that the ordinary house carpenter, as employed by the contractor in building work is not always the most efficient bridge man. In fact, we have to train many of them for our work before they are very much good to us. I have found in my experience that the best men that I have to-day are many of them, men whom I took as green country boys, employed them at laborer's rates, and as they learned our business, advanced them from one stage to another. In fact, one of my most efficient foremen to-day is a man whom I employed as a laborer when he was perhaps 19 or 20 years of age, and he has been advanced constantly.

There are, of course, objections to this plan. It puts a great amount of responsibility on the supervisor, because not all of the foremen see the system as a supervisor does and they want all their men to get the highest rate.

Another point I would like to bring out is that the so-called sliding scale or the differential rate should not be based upon length of service. For instance, I have some men in my gangs who are employed as helpers and have been for years, and while they are most efficient helpers, they will never be able to take a mechanic's rating. I think the promotion from one wage rate to another should be based almost entirely on the efficiency of the men and the spirit which they manifest in the work that is assigned them. If they are interested, if they try to do their best, if they are putting forth every energy in their power to do the company's service as they would if it was their own business, these men are certainly entitled to some consider-

ation, and while other men alongside of them may be doing just enough to get by and not receive any censure for not doing their best, at the end of a specified time if the man who is working for you and giving all he can, is not advanced over the man who is not, it is manifestly unjust. The man who is giving his life to the service should be the man who is advanced. The man who is doing just as little as he can and not merit a calling down, should be kept in the position he is in until he shows a disposition to improve and do his best. As I said before, that puts a great weight of responsibility on the supervisor.

There is another phase of the question that we are up against in the east, and that is the labor organizations. A bridge gang is usually composed of from 8 to 12 men. Perhaps two or three or four of these men will be rated as carpenters, and yet they get a lower rate than the highest paid men. Then the labor agitator comes along (and the labor union is pretty strong in the east) and he says, "Here is John; why doesn't he get as much pay as Jim; he does the same work?" The labor organization never takes into consideration the efficiency, the spirit and the honesty of the man. To the labor agitator it is simply that one man is the same as another man and if he is rated as a carpenter he should get the highest carpenter's rate of pay.

We have to fight against those things, and we have to do it by humane principles. We have to do it by showing our men that it is our interest in them and their interest in our work that shall enable them to advance by merit, by efficiency, by earnest, conscientious service, and not by union rules.

W. E. Alexander:—I have had charge of men ever since I was big enough, and I never had charge of a crew on a flat rate. I never was in charge of a crew in which there was not some differential in the wage. I have not been tied up with organizations to such an extent as to have to pay the poor man the same as the good man. That hampers the organization. The flat rate is the thing that demoralizes labor, because the poor man will do no more than he did before, and the good man will do only as much.

HOW TO SECURE AND HOLD BRIDGE AND BUILDING MEN

By J. P. Wood

Supervisor of Bridges and Buildings, Pere Marquette, Saginaw, Mich.

The problem of securing and holding bridge and building forces is the most serious of any that confronts this department at the present time, and I believe I am safe in saying that it is more serious at present than it has been at any other period in the history of railroading. It is the greatest worry that the supervisor has. He may think that the stores department is lax in securing his material and the operating department slow in moving it, yet without men he can do nothing with it after it arrives. If the railroads were allowed to raise the price of the commodity they have to sell the same as other corporations and firms have done, a better scale of wages could undoubtedly be secured, which would eliminate a large part of the trouble that we now encounter in securing men.

The old song we have all sung so often when hiring men that it is a year around job with practically no lost time and a few passes for a man and family each year does not make much of an impression on a man now as he can get a job that pays more in a factory or shop and at the same time be at home with his family. This applies more particularly to the city man than to those residing in the small towns and country. Many good men can be secured in the smaller towns where there is not enough work to keep them busy the year around if a judicious canvass is made by the supervisor and his foreman among the business men in these places who are usually willing to coöperate along these lines; and by having the local agent keep you posted as to the movements and whereabouts of the men you have in view, and as to the progress of building operations in that vicinity so that you will know at about what time these men will be out of employment and looking for more. Then is the opportune time to go scouting for them.

The city man constitutes a different problem as he is much more difficult to get in touch with. Yet by keeping in close touch with contractors and manufacturers who employ mechanical help, one can always secure a certain element that make good men for our class of work.

There is another point that I want to emphasize which applies both to securing and the holding of men and I believe it to be the most important of all. It is your reputation. I imagine some of you will smile at this statement, but when you stop and analyze it you cannot do otherwise than to agree with me that your reputation is of vast importance among your men. When your men come to realize that you are strictly honest with the company you represent, ever watchful to guard and protect its interests as you would your own; when they come to realize that you are just as careful to guard and protect their interests, ever ready and willing to take the lead in fighting their battles when their cause is just, ever willing to listen to their complaints and grievances and rendering your decisions in a manner that shows you have no favorites, and that the most menial laborer in the gang receives the same consideration that your best foreman does, that you are ever ready to advise and instruct, conducting yourself in such a manner that they see at once that you are made of the same kind of clay that they are, becoming acquainted with their family affairs so that you can share

in their joys and sympathize in their misfortunes; these are the things that command the respect and confidence of your men and build for you a reputation that goes out and reaches farther than the chair you occupy in your office.

Much can be said on how to hold men. I want to call your attention to some of the more important points. The supervisor should be a diplomat, as on his ability along these lines depends his success to a certain degree in holding the men. Also he must use great judgment in selecting a new foreman as on this choice rests his further success. The oldest man in point of service or the best mechanic does not always make the best foreman. Rather one should look for the one with the best executive ability, as he rarely fails.

When out where the work is in progress study your men as to their ability to perform their tasks and observe how they get along with other men; whether they are looking for something to do or have to be told. By constantly keeping watch of your men along these lines, when the time comes when you want a foreman your choice will probably have been made long before, and if you have chosen wisely a great part of your worry about holding the men has been eliminated, as the average man will overlook many things if he has a good foreman to work under.

Let the men go home as often as is possible if it is every night: they have wives and babies, mothers and sweethearts the same as you and I had when we were working in the gang. While you will have to use a certain amount of discretion in issuing passes don't be stingy with them. We are all aware that the prices of paper and of printing have advanced, also that the supply of good men is getting scarce and they are hard to procure; then why should we take any chances of losing a good man that it has cost the company dollars to educate for the sake of saving a few passes? The company might better furnish the passes.

Get the best equipment that you can for camp cars and make them as home-like as possible, looking well to the things that make for the comfort and health of your men, providing sanitary bunks, plenty of such utensils as are used in camp cars, good ventilation, as much room as is consistent with the number of men carried, not forgetting a liberal supply of brooms, mops, scrubbing brushes and paint, and insist upon absolute cleanliness in and about the camp, as it helps to keep the men satisfied.

Another point I wish to bring out is the use of labor saving machinery and devices, not only as a means of holding the men, but at the same time as a money saver for the company. While I am aware that it is sometimes a hard matter to get your superior officers to see these things as you do, yet with some effort on your part you will find means whereby you can lay the cold facts before them and usually win them to your point of view. Then it is an easy matter to place your order with a surer prospect of getting what you want, thereby reducing your cost of operation and keeping the men better satisfied.

These and many other things that can be done to better the conditions of your forces are what count for contentment among the men, and are appreciated by them. By keeping them contented and satisfied you will have less trouble in holding them.

WAGES AND TRANSPORTATION IMPORTANT

By W. E. Alexander

Superintendent of Bridges and Buildings, Bangor & Aroostook, Houlton, Me.

My experience in recent years has been with a railroad running through a sparsely settled country where there are not enough men even in normal years to carry on the regular business of farming, lum-

bering and manufacturing. These industries are therefore competing all the time for the best native labor. For this reason it is difficult to secure even the unskilled men we want at any time, and as there has been little railroad construction in recent years it is almost impossible to hire new men with any experience whatever in bridge work.

At certain seasons, farmers, lumbermen and millmen will offer much higher than the normal rate of wages, which induces the younger men to leave the railroad service with its lower rates of wages; and it is only occasionally that a man can be held until he is educated to fill the position of a bridge and building foreman. The members of this association will agree that this is an important position, and under present conditions of traffic needs a careful and competent man.

Men for our crews are hired from those who apply for such work, or from the general labor market wherever they may be picked up. When possible, they should be hired by the foreman under whom they are to work. The first consideration of the laboring man is the rate of wages. Unless the compensation offered is somewhere near the "going" rates in the country through which the road runs, it is obvious that the proper class of men cannot be secured, though I find men generally fair to make allowance for steady work and other benefits in railroad service.

The wage question at the present time is a most serious one for railroad managements. There is an unprecedented shortage of men. Railroads cannot afford to pay the high rates now paid by other industries. Where wage schedules are definitely fixed we must do the best we can with the rates allowed. In my opinion, wage schedules for bridge and building men should be on a sliding scale, rising gradually from the lowest rate paid beginners to the highest allowed; and the head of the department, in consultation with the bridge and building superintendent and after recommendation of the foreman, should have authority to advance any man to the higher rates of pay, up to the limit allowed by the schedule as he becomes fitted. This will stimulate the men to do better work and fit themselves for the higher grades. Further, in hiring men, they should be fully informed of the advantages that railroad work offers; steady work, regular pay, low cost of board in outfits, passes and other privileges.

How to hold men after they are hired is an open question in all departments. It is clear that most men leave for higher wages. If the railroads do not pay as high wages as other companies and individuals, a proportion of the men will leave. To hold the men then, it is absolutely necessary that the management be thoroughly informed of the situation by the men who actually know all the conditions, and allowance enough be made to hold the reasonable men. This should be done as soon as possible, so that men do not become dissatisfied, as it is much easier to hold good men than to get others to fill their places after they have gone. When they understand the privileges granted them including free transportation to go home as often as reasonable, free transportation for their families on the road they work on, refund on personal freight, etc., they are more likely to appreciate their jobs. A thorough understanding between the foreman and supervisors and the men produces the best results. The best methods of doing work also need to be applied, as this is best both for the companies and for the men. In short, if men are to be retained in railroad service, they must be paid wages that are reasonable in comparison with those in their territory and have fair treatment and steady employment, with a chance to advance in position and wages as they become fitted. Good working and living conditions and such privileges as can properly be accorded by the company are also very essential. This applies to all classes of men in railroad service.

PERMANENT WORK AND GOOD CAMPS ESSENTIAL

By F. L. Burrell

General Foreman Bridges and Buildings, Chicago & Northwestern, Fremont, Neb.

The prime factor in securing bridge men is the wages paid per hour. There is no use of expecting to get experienced men at green-hand prices, neither should one be expected to pay green men experienced men's wages. Therefore, the first step is to get a basis of wages at reasonable figures for the different classes of labor required.

The next step is to get the operating officials to allow the organizing of gangs early in the season. In making up the gangs have a personal talk with the men, collectively or individually, as the opportunity may present itself, and have it understood that no man is guaranteed long time employment but that the persons employing them will do all in their power to hold them continuously so long as they do their part by showing a desire to give a full day's work to the company; and that if any vacancies occur the older men in point of service will be promoted and get the higher wages that go with the positions, if they are competent to fill the place.

The person in charge should arrange his work to give the best men winter jobs. This is necessary on account of the probability of emergency work when the most experienced men and best workers are needed. This also gives them a chance to work up to the position of foreman.

The men we get now are not of the old rule-of-thumb class with the log fire or candle light education. Many are high school men, and they are not without ambitions, for most of them turn to farming or small machine shops of their own after they shall have reached a gang foreman's position, as there is poor prospect of further advance. This makes it necessary to keep good men to follow the retiring foremen.

One of the most necessary steps to take in holding men is with reference to the housing. If an outfit of bridge men is allowed to "bach" it in the cars there will be less trouble in holding the men. This requires three cars to the gang, one used for a cook and dining car. The men may get their own meals at a great deal less cost to them and at no more cost to the company, making it more satisfactory all around.

One of our gangs has a man who is a good worker as a bridge man, and who is also a good camp cook. He gets out at 5 a. m. and has breakfast out of the way and the men are on the job at 7 a. m. Supper is cooked after 6 p. m. If the men are near the cars at noon this man goes in at 11 o'clock and gets the noon meal. The whole gang works overtime to make up for the cook, without charging the extra time to the company, and distributes the extra time of the other two meals among themselves. They also pay for the food in the same manner. We have held the gang together in this way for two years and can depend on the men to work cheerfully in any emergency—overtime, rains, snow or floods without a growl or grouch. This outfit could not get beds in a hotel for the men at less than 50 cts. per night at any point on their territory, and cannot get a laboring man's meal along the line at 35 cts. They board themselves at a cost of 18 to 22 cts. per meal (including the extra cost of the cook at night and morning), and have just what they want to eat of common, wholesome food.

We would also suggest furnishing outfit cars that are warm and comfortable enough to allow changing clothes and drying them in cold, wet weather. These cars should be provided with modern bunk car iron beds with springs, as the car is the home of the men the year round.

If the railroad would provide these two conveniences and even furnish a cook, it would be more than repaid, as the principal objection to the wages paid is the cost of bed and board.

We do not think it necessary to offer the high wages paid by the contractors for experienced help as such work is intermittent, while part of the bridge and building work, if properly handled, can be made continuous and furnish a steady job most of the time. The lost time looking for a job is largely eliminated and the continuous wage at a less figure is more attractive, where living can be had at a minimum, than the lost time at higher wages, caused by the necessity of hunting a new job, and perhaps, paying for transportation to the new job, with the possibility of being unable to suit the new foreman or employer after the new job is found.

FUNDAMENTAL CONSIDERATION IN HOLDING MEN

By E. C. Zinsmeister

Master Carpenter, Baltimore & Ohio, Norwalk, O.

How to secure and hold bridge and building men is a subject of vital importance. Should the war continue, causing continual demand for men for military service, the condition will be of more concern each month throughout the time the conflict continues. The men who at present are being drafted for military service are of the proper age to give good work on bridge and building work problems.

In my opinion, there are four important features necessary to secure and hold men: (1) The scale of wages. (2) Camp facilities. (3) The personality of the foreman. (4) Favors granted by the railroad.

The rate of wages paid is the first subject of inquiry made by a man looking for employment, and, if not sufficiently attractive, the man will look elsewhere for work. In bridge gangs, I would recommend three different rates of pay, and for building work two different rates other than that paid the foreman. This allows the grading of the men and those employed at a lower rate look forward to a place at a higher rate, which I believe is some inducement for them to stay on the work.

The camp facilities are also a very important consideration and should be composed of sanitary, well-ventilated cars.

The personality of the foreman is a very important aid in holding men on the work. The foreman should make a study of the personality of each man in the gang, and thereby learn how to approach him and keep him in a good humor and a willing worker.

Favors granted by the railroad also have influence in holding men in the service, as for instance, the issuing of a card pass with limits based upon a scheduled number of years in the service, with similar privileges for the wife also.

Sunday work should be avoided as much as possible except in cases of emergency. In emergency the feeding of the men and the number of consecutive hours on duty are important factors and should receive due consideration.

FUNDAMENTAL CONSIDERATIONS

By J. S. Lemond

Assistant to Chief Engineer Maintenance of Way and Structures, Southern Ry., Charlotte, N. C.

We should have the best camp cars obtainable for our bridge and carpenter forces when they are to be moved from point to point. The cars should not merely be something to shelter the men, but they should be good, comfortable, conveniently arranged, and neatly kept, well heated and ventilated, and as homelike as is possible to make them, as these cars are the homes, practically speaking, of these men. The pay of these men should be on par with that paid for similar work in

the section where the men are employed and regular employment should be assured them. Good cooks should be furnished by the company whose duty should be to prepare the food in the proper manner for the men and care for the camp cars, keeping them in neat and clean condition at all times.

Where it is practical to operate them, motor cars should be furnished the men, as it is to the interest of the company and the men to do so. The foremen should treat the men humanely, at the same time see that the company is served faithfully by keeping them diligently employed. Those of the men who have families should be accorded the privilege of going to their homes at the end of each week, when the interest of the company does not suffer thereby.

DISCUSSION

The President:—It has always been a mystery to me how railroads can get and hold such good bridge and building men as are working on the roads at the wages that are paid in comparison with wages that are paid for work that can be done by those men in the communities in which they live. I don't know what it can be, unless it is the various little concessions the men get and the regularity of the work. But I think these papers that have been read will give us all something to think about as to the way in which the work can be made a little more desirable to the men.

For example, in going out over bridge inspection trips, I have always made it a point, where I could, to eat in the bridge cars. That one thing gave me a good sidelight on the living conditions of the men. Most generally I found the meals were good, but occasionally I ran into a camp where the eating was very poor, and those outfits generally were short of men; good work could not be done, and all things considered, the work accomplished was on a par with the food that was served. A little more effort and supervision by the supervisor in the right direction would often induce the men to stay.

Another thing I ran across a great deal, and I think it is more necessary to watch it now than ever before, is the privilege of letting the men get away often. I have known men to stay on the jobs, when they are far away from home, for several months at a time, for the reason that in order to get home they would have to leave a half-hour or an hour earlier on Saturday and perhaps get back a little late on Monday morning, and for that reason the foreman, who had a lot of work to do, thought he would hold on to the men in order to get every day of the week in and deny the men the privilege of going home

as often as they might have gone had a little of that time been lost. I think that by losing that little bit of time the foreman would get a great deal more work out of the men by letting them go home oftener.

One other thing that comes to my mind is congeniality. It sometimes happens that one man is a perpetual grouch, and while his services may appear very necessary to get the work done, the gang would be better if he wasn't there.

I have had a lot to do in arbitrating contentions and disputes arising on street railway companies' forces, and I know that the men always insist that where the motorman and the conductor of a car are not congenial, they be changed and put on separate lines. If a man is a perpetual grouch he had better get out.

I think some of the discussion can be applied as well to the next paper as to this, Housing and Feeding Bridge and Building Maintenance Crews, by F. E. Weise. After Mr. Weise presents his report we will continue the discussion.

Now you men here have had so much more to do with that than I have, that I am sure you can contribute something to the discussion after hearing these papers read, that will be very valuable to the proceedings.

B. F. Pickering:—I was very much interested in those papers and especially in the point brought out by Mr. Wood regarding our personal reputations. I think that the thoughts brought out in that idea go farther towards securing good men and keeping them than any other factor in the holding of men in boarding car outfits. In the territory which I cover we have a great many boarding car outfits, but we also have quite a number of local forces, for, of course, men don't care to go into a boarding car outfit, where it will cost them approximately $3 a week for food, if they can get into a local crew and be at home. That is quite natural. As a result we have hard work to get men for the boarding car crews.

I have found that not only my own reputation, but the reputation of the foreman the men are going with counts a whole lot. If he is a man who looks after the interests of the men the same as he does those of the company, and considers every man as a man, and not as so much machinery and so many tools, he is very much more likely to get good men and hold them than a man who has a different reputation. I believe that we should

make our outfits as comfortable and homelike and as pleasant to our men as we possibly can, consistent with the expense involved.

I have been trying an experiment recently which has worked out splendidly. During this summer we found the greatest difficulty in securing cooks. We have several cantonments in our territory, and as the army is paying high wages for cooks, quite a number of our best cooks left us. This created a problem; we did not want a drunken cook for he is worse than no cook at all; we did not want a cook who was not neat and clean, for uncleanliness is the next worse nuisance. It got to be a very serious problem with us, and finally I hit on the plan of either selecting some man in the crew or of employing a man who could go in the crew who had a wife who was a good cook, and who had no children, putting the wife into the cook car (a portion of the cook car is partitioned off, making a nice room for the man and his wife to occupy). The wife does the cooking, and the plan is working out fine. Somehow,—I don't know how it is,—but the woman adds a few homelike touches to the car, and it makes the men feel more as though they were at home.

I was struck greatly with that thought just before I came away. I had just started an outfit of that character; perhaps the woman had been in the outfit two weeks, and I hardly knew the camp myself when I got in it. Instead of being merely a bare place for the men to live, sleep and eat in, she had touched up here and there and added a few things, which I couldn't specify, but which made it seem like home. As I went among the crew, and through the car the men were loud in praise of the new cook. They said it was just like being at home, and that counts a great deal in keeping the men.

I think we should allow the men to get home as frequently as possible. In fact, I make it a rule, wherever possible, unless they are to work over the Sabbath, for them to go home Saturday afternoon and return Sunday night or Monday morning, if conditions will permit.

I am democratic enough to believe that a supervisor is none too good a man to speak with his men and allow them to consult with and associate with him, even the humblest man in the ranks. Of course, I have so many of them that I can't remember all their names, but I can remember their faces, and I

believe it does a great deal of good for a man, whether supervisor or foreman (and the higher the position the more good it does), to get around among the men and say, "Hello, Jack; Hello, John—how are you?" Treat them as though you consider them of some consequence in your business, and I think you will get better results.

THE MATERIAL PROBLEM

With Reference to Bridge and Structural Steel

By Albert Reichmann
Division Engineer, American Bridge Company, Chicago

The material problem in reference to bridge and structural steel has been assigned to me for discussion—a task I can assure you to be no small one under present conditions. The breaking out of the European war created great activities in practically all lines of American commerce and industry, in which the natural economic laws of supply and demand governed. Unfortunately the railroads, while enjoying these activities to some extent, could not enjoy the fruits thereof to the full extent and they were, consequently, retarded in their natural development for which we are now suffering. Owing to the prevailing uncertainties of the present situation, it is most difficult to analyze correctly the material situation of today. To convince oneself of the difficulty arising out of the situation, he has only to read the predictions made by eminent political economists and statesmen at the beginning of the great conflict.

As our steel conditions are intimately related to present European conditions, it might be well to give some idea of the approximate maximum annual production of the various steel producing countries which are at present engaged in this war. The production of

Great Britain in 1915 was	8,351,000	gross tons
France in 1913 was	4,635,000	metric tons
Russia in 1914 was	4,817,500	metric tons
Belgium in 1913 was	2,467,000	metric tons
Canada in 1915 was	911,000	gross tons
Italy in 1913 was	933,500	metric tons
or	22,115,000	tons

The production of the Central Powers was:

Germany in 1913,	18,959,000	metric tons
Austria-Hungary in 1915,	2,686,000	metric tons
	21,645,000	tons

There is such a slight difference between metric ton and gross ton that I have not reduced these to the same equivalent.

Owing to the fact that at least two-thirds of the French, and practically all of the Belgium steel-producing facilities are in the hands of the Germans, the available European steel supply of the Allies is reduced to about 16,558,000 tons; whereas the Germans, undoubtedly, get some benefit from the Allies' properties which are under their control. Consequently, a large amount of steel must necessarily be furnished the Allies by this country in order to meet with their requisite supplies for the conduct of the war.

It is frequently said that steel is either "Prince" or "Pauper" in reference to business conditions. It certainly is "Prince" in all activities connected with modern warfare. Present day warfare is so inti-

mately correlated with industry that the nations with a highly intensified industrial development have a decided advantage in the conduct of the war. This is especially true of the steel producing nations.

It is certainly very gratifying that our nation has such wonderful industries at its command. All thinking people must feel truly grateful to those wise statesmen who advocated and enacted the laws which fostered our industrial development.

Prior to the war, the maximum production of steel in the United States was 31,300,000 gross tons in 1913, which, owing to the activities produced by the war, was increased to 42,773,680 gross tons in 1916 (and is being still further increased during the present year), from which it will be noted that in 1916 the United States produced approximately 50 per cent of the entire steel production of the world.

To meet our own requirements of the war, as well as those of the Allies, it was necessary for us to construct large plants, built almost entirely of steel, for the manufacture of everything used in carrying on the war, such as rifles, cannon and ammunition, as well as products pertaining to transportation, such as boats, locomotives, cars, rails, etc.

Whatever the national welfare depends upon should be provided regardless as to whether it pays commercially per se or not. A good national mercantile marine is one of these necessities. I feel quite confident that those statesmen cannot but feel deeply chagrined at their lack of foresight, who, knowing that commerce is the life blood of the nation, either stood in the way of or failed to assist in legislation which was intended to encourage or foster the building of a mercantile marine, which we so sorely need at present. We are now called upon to supply our one great need, namely: ships, which I can assure you will be no small undertaking. According to press reports we are to build 6,000,000 tons of shipping in one year. To give you an idea of the magnitude of this enterprise, I need merely state that the world's production of shipping in 1913 was 3,333,000 tons, of which Great Britain produced about 2,000,000 tons.

The construction of ships will necessitate the building of great ship yards. Thanks to the fact that our producing facilities have been increasing for some time, and furthermore, that many of our industrial plants can be used in conjunction with the shipbuilding plants, the output of this industry can be both hastened and materially increased.

Of the total production of steel in the United States, structural materials consisting of steel bars, shapes and plates constitute about 12,400,-000 tons. According to one of our New York leading financial publications, it is expected that the Government will require about 7,400,000 tons, leaving about 5,000,000 tons for other uses.

As all steel producing plants are booked ahead for a very long period and many orders are for material needed in connection with industrial and other purposes which are not essential from a national defense standpoint, the United States Government has established what is known as a "Priority Committee" with Mr. R. S. Lovett acting as chairman.

Through the issuance of so-called priority classes and numbers, rolling mill schedules are arranged so that the material which is needed most urgently by the Government, as well as on Government work, is given preference. This applies not only to work for the Government, but also to other work which is just as urgently required, such as ship building plants, ships, and certain classes of railroad work considered necessary for the national welfare.

The regulations respecting priority which must be observed by all producers of iron and steel, as well as the manufacturers of products thereof, are briefly as follows:

All work shall be divided into three general classes designated as Class A, Class B, and Class C, with various sub-divisions indicated by a suffix number, as Class A-1, Class A-2, Class B-1, Class B-2, etc. All

work in Class A shall take precedence over work in both Class B and Class C and work in Class B shall take precedence over work in Class C, irrespective of the date the orders were received. Work in Class A-1 shall take precedence of work in Class A-2 and work in Class B-1 shall take precedence of Class B-2, etc.

Class A comprises war work, that is to say, work urgently necessary in carrying on the war, such as arms, ammunition, ships, etc., as well as materials required in their manufacture.

Class B comprises work which, while not primarily necessary for carrying on the war, yet is of public necessity and essential to the national welfare.

Class C comprises all work not embraced in Class A or Class B and no certificate of the Priorities committee will be required therefor. However, an order for work or material not accompanied by a certificate to the effect that it falls within Class A or Class B will be treated as an order for work in Class C.

After a careful consideration of the steel problem, both with reference to production and to the apparent government requirements, it would appear that there will be sufficient tonnage remaining for ordinary construction purposes with a reasonable time for deliveries.

DISCUSSION

The President:—Mr. Reichmann stated in his closing statement that with the present production it appeared that, allowing a reasonable time for delivery, there will be plenty of structural steel manufactured. However I still think that whenever you men can avoid the rebuilding of a bridge and adopt some other expedient to cut down the demand for steel at this time, it will ease the situation up in the steel market. No doubt some of you have encountered this problem already and have adopted some other expedients, on account of the high prices or the delay in deliveries.

The Yellow Pine Situation

By Dr. Herman von Schrenk, St. Louis, Mo.

I have been asked to say a few words about the material situation as far as yellow pine in the south is concerned in connection with construction work. While I am usually very much of an optimist along those lines, the story I have to tell about the immediate supply of construction timbers of southern yellow pine is not quite as optimistic as I would like to have it. Most of you know that during the past four or five months the Government has made demands upon the yellow pine industry such as have never been made before. The construction of the large number of cantonments has taken millions and millions of feet of the stocks that were on hand at the mills, and I don't

think it is claiming too much to say that the yellow pine industry has acquitted itself of the national responsibility in a manner which it certainly has every reason to be proud of. Most of the material taken in the cantonment construction was small dimension stock; the large sizes were not so much in demand; but just last week the Government issued an order commandeering practically the entire output of every southern pine mill from Texas to Virginia for all timbers 12 in. by 12 in. of 30 ft. length and larger. You can realize the necessity for such action when you contemplate the present shipbuilding program which the Government has outlined,—260 ships, requiring an average of 1,600,000 ft. of timber per ship. Our facilities for getting out this number of ships and carrying out this program probably will mean continuous operation of the plants for a period of not less than 18 months. In other words, the great bulk of the structural timbers of that size must now be saved for the emergency program.

Sixty of these vessels are building at the present time on the South Atlantic and the Gulf coast. Doubtless a good many of the timbers will also be supplied from the mills of the Pacific coast region, but the supply sent east will be comparatively small. It behooves those who are located in the eastern and central territory to recognize this state of affairs and to bear patiently with the situation.

The question has already been asked me from four or five sources as to what we are going to do about it, in view of the commandeering of the material by the Government. That is not quite as hopeless as it appears at first, because the Government is making every effort to so classify the needs that the legitimate demands of the industry shall not suffer. They have put the matter in charge of a committee which will determine the necessity of the case in each individual instance. When any particular railroad has to have timbers for repairs or new construction work in order to maintain its line, the proper procedure will not be for the purchasing agents to go promiscuously to their former mill friends or the manufacturers who formerly furnished them materials, because that will do them no good. The proper method of procedure will be for that particular railroad to approach the lumber committee of the National Council of Defense in Washington with specifications drawn up for what it needs, or to address the office of the secretary-man-

ager of the Southern Pine Association in New Orleans, who will in all probability transmit that information to the lumber committee of the National Council of Defense. This committee will pass upon the necessities of the individual cases and issue such instructions as will in all probability release the necessary material whenever it is needed.

Nobody can tell how long this will last. There need be no question whatever about the smaller sizes. They are available in abundance, and while the stocks are somewhat depleted at the present time, owing to the slowness with which freight is being moved, there ought to be no difficulty in getting the small stuff in the future just the same as in the past.

The second problem we are all up against—and this applies to all kinds of lumber—is an attempt on the part of those of us who are entrusted with the responsibility for the handling of the materials to change our ways. We must get the maximum service out of the timbers that we already have in structures or on hand for repair work. If we have never practiced conservation in railroad work before, it is now time for us to get busy and study out the best ways and means of doing it.

We have all been more or less reckless in the conservation of our stock and there is not a single day that goes by but that we find stuff which we can make serve purposes that it does not do at the present time. We have been over-fortunate up to this time in having an abundance of material to depend upon, and some of us have gotten to be shiftless in the way in which we have utilized material. But if we all take heart and pull together, we will be able to keep the railroads up and keep the trains running in a state of efficiency which I think the Government has a right to expect of us.

The Douglas Fir Situation

By O. P. M. Goss, Seattle, Washington

I could follow out just about the same line of information as that which Dr. von Schrenk has given you. His explanation practically fits the west coast districts. However, I think that perhaps we have had one trouble out there which Dr. von Schrenk has not had to the same extent, and that is the difficulty with strikes. We felt pretty blue at one time. You must have

heard the news that came back from that section about the I. W. W., and what they were doing. But we didn't give up. We quit everything else and went to work on anything necessary to help keep up the production. I will say that at one time our output was curtailed to about 35 per cent of normal. That certainly looked serious, in view of the fact that we had Government orders for a large number of ships, and we also had orders for a large number of similar ships being built for private concerns. In view of those large orders, all of which had to be hurried to the limit, the strike situation made us pretty blue, but, as I said before, we did not give up; we simply plugged and plugged and finally have worked through it. When I left the coast we had increased the production to about 75 per cent of normal. That production has gone into ships and cantonment materials for various parts of the United States.

We, of course, depend entirely on Douglas fir for what you might term structural timber. About 25 per cent of the standing timber supply in Oregon and Washington is of Douglas fir.

In getting out the spruce, our strike situation developed something new. After collecting the data and finding out where the trouble lay, we uncovered a movement to curtail all logging operations in the spruce camps. When we had satisfied ourselves as to what the situation was, it looked serious, but fortunately the Government came along with the final stroke which I think absolutely broke the back of the I. W. W. Now the spruce camps are all operating again, but not until the Government commandeered practically every mill and logging camp along the coast. The strike condition is getting better from every standpoint all the time, and from now on I can't see why we should have any trouble in getting the material out for the Government or for railroad work.

Now, as to the facilities for getting the lumber here. We have plenty of cars now, although the shortage was serious for a time. We have been able to ship lumber just as fast as it was required and we don't expect any great difficulty in that respect. We are rather proud of our accomplishment in getting material for one cantonment in Wisconsin in just six days. We sent a number of full train loads which came through in that short time. We felt that was a sign of pretty good operating facilities on the part of the railroad, which, in that case, was the Northern Pacific.

Water Service Materials*

Paper by C. R. Knowles
Superintendent Water Service, Illinois Central R. R.

Although a very conservative estimate of the increased cost of all materials used in maintenance of way work has been given as 30 per cent, I think we can safely say that, with few exceptions, this figure will come nearer representing the minimum increase in the cost of water works materials, many items having increased several hundred per cent. The unprecedented prices and the uncertainty of delivery have created conditions which make it very necessary to employ methods that will help to conserve materials used in water works construction and maintenance, especially with such materials as are particularly difficult to secure.

From the present outlook some relief appears in sight as regards prices of certain materials, the price of cast iron pipe having dropped $15.00 per ton on October 1, although with the government and foreign requirements in addition to the greatly increased domestic demands for materials of all kinds we cannot hope for much relief in the near future as far as deliveries are concerned.

While all materials have advanced in cost the increase has been more marked in iron and steel products, and articles manufactured from brass, copper and other semi-precious metals. Boilers have doubled in cost with indefinite dates of delivery on those built to specifications. Steel tanks of all kinds have advanced from 100 to 150 per cent, tank hoops from 75 to 100 per cent, steam pumps from 40 to 50 per cent, and oil engines 30 to 40 per cent with deliveries from 3 to 9 months in the future, depending on the size of the units.

All stocks of steel and wrought iron pipe have been depleted and it is difficult even to get a quotation on a definite date of delivery on large pipe. The following table indicates the approximate prices prevailing on steel and genuine wrought iron pipe from 1914 to date:

	Steel Pipe	G. W. I. Pipe
January, 1914,	$43.00 per ton	$55.00 per ton
July, 1914,	42.00 " "	54.50 " "
January, 1915,	43.00 " "	55.00 " "
July, 1915,	44.00 " "	55.50 " "
January, 1916,	47.00 " "	59.00 " "
July, 1916,	68.00 " "	85.00 " "
January, 1917,	82.40 " "	103.00 " "
July, 1917,	114.40 " "	143.00 " "
October 1, 1917,	114.40 " "	143.00 " "

The above prices apply to base sizes, that is, ¾ in. to 3 in. B. W. steel and ¾ in. to 1½ in. B. W. genuine wrought iron. It is impossible to prepare a table on larger pipe that would indicate even an approximate price as all quotations have been based on delivery and stocks on hand. To illustrate the scarcity of large wrought iron pipe, one of the largest oil well supply houses in the country, has pulled well casing from the ground that has been in use for 19 years and paid the owner of the wells 20 per cent more for the pipe than was paid for it when new, 19 years ago. The pipe was then sold for double its original cost.

Delivery on cast iron pipe has been fairly good, although the price has more than trebled in two years. We are laying cast iron pipe today that ranges in cost from $18.50 to $60 per ton. while the lead used in making the joints has advanced from $3.75 to $11 in two years.

*Forming part of the Report—The Material Problem.

The following table shows the range in cost of cast iron pipe from 1912 to date:

Year	1912,	Approximately	$20.65	per net ton
"	1913,	"	20.35	" " "
"	1914,	"	18.50	" " "
"	1915,	"	18.60	" " "
"	1916,	"	25.00	" " "
January	1917,	"	32.75	" " "
July	1917,	"	49.30	" " "
October 1,	1917,	"	60.00	" " "

In justice to the cast iron pipe manufacturers it may be said that the increase in the cost of pipe has been more gradual than the advances in iron. This may be explained by the fact that the cast iron pipe manufacturers had some iron bought ahead and only advanced prices as the old contracts expired.

There are many reasons for the difficulty in securing material and delay to shipments, the chief reason being on account of the enormous amount of material going to foreign fields and taking precedence over orders for materials for domestic use. The shortage of labor and labor troubles have also had a serious effect on the material situation. The labor situation is daily growing more critical and will continue to affect the delivery of material. We cannot look for much if any improvement for the duration of the war.

It is along the line of salvaging old pipe lines that the greatest good may be accomplished in conserving water works materials. The salvage of cast iron pipe is almost 100 per cent. Except for the cost of removal a cast iron line is of as much value when taken out of the ground after years of service as when it was laid. It is true that a year ago with cast iron pipe at $18 per ton the cost of removal would have in many cases almost equaled the cost of new pipe, but with pipe at $60 per ton the removal of old lines is a paying proposition. In many instances wrought iron pipe may also be salvaged to good advantage. For example 600 feet of 5-inch genuine wrought iron pipe laid at Hampton, Miss., on the Yazoo & Mississippi Valley was recently removed at a cost of less than 10 per cent of the value of the pipe. This pipe was in excellent condition notwithstanding the fact that it was laid 30 years ago.

The saving effected by the conservation and salvage of second hand material is not confined to pipe alone but includes all classes of materials. Tank hoops may be repaired and used on other tanks. Sound staves and bottom plank may be utilized in the construction of smaller tubs; valves and fittings may be repaired at a small cost and made to answer for new. Rubber pump valves may be faced off and used again; pump packing worn too small for one pump may be used in a pump requiring smaller packing. In fact with present price conditions there are but few items that will not justify the spending of considerable time and effort in their conservation.

In many cases standards may be revised, substituting material expensive and difficult to secure with that less expensive and more easily obtained. For example we have changed the design of our water column pit, eliminating about 3,000 lbs. of castings and several hundred pounds of reinforcing bars and I believe we now have a better designed pit than we had before. The difficulty in securing steel plates and the great increase in cost of steel tanks have forced many railroads which had practically adopted the steel tank as a standard to return to wood. The high price of steel has also stimulated the interest in concrete tanks and there is great activity along this line. The high cost of cast and wrought iron pipe has caused many roads to give serious consideration to substituting wood stave pipe for iron pipe.

A great deal may be accomplished in conserving materials by overhauling scrap piles and reclaiming second hand material, also by cleaning out shelves, boards and the pump houses of the ever-present accumulation of globe valves, fittings, etc., held for a fancied emergency that never occurs. Scrap has advanced in price to such an extent that in some instances the scrap value of an article is in excess of its cost new a few years ago, consequently scrap should be kept cleaned up and forwarded promptly to the storehouse in order that it may be disposed of to the best advantage.

It has been truly said that, "The ways in which material and supplies are wasted on a railroad are as many as the number of persons in its employ," and if we may learn the lesson of economy in the use of materials from the present situation it will not have been without its good effect.

DISCUSSION

C. R. Knowles:—Although a very conservative estimate of the increased cost of materials entering into the maintenance of water works, has been given as 30 per cent, I think we can safely say, with few exceptions, that this figure will come nearer representing the minimum as regards water service materials, many items having increased several hundred per cent.

The prices for steel products recently set by the Government will not be available for the general public, on account of the demands of the United States and the Allies overtaxing the capacity of the mills. However, it has tended already to lower the market price and will put steel products within the reach of the railroads' purchasing power. Heretofore, it has not been a question of whether you wanted to pay the price for it, but you couldn't get the material at any price. Today you can not get wrought iron pipe larger than 6 in. in diameter at any price.

The President:—You have heard the papers on the present bridge and building material situation as to structural steel, timber and water service materials. One thought occurs to me, and that is that if the demands of the Government are going to continue for some time it will make tremendous inroads on the steel production. The demands of the Government caused a heavy demand for timber for the cantonments, which made it very difficult to get anything while the cantonment construction was going on, but I am inclined to think that the situation was practically temporary, because they are completed now. We have also heard of the water service situation. As steel and timber were very hard to get, I think that that condition will cause us in many cases to turn to other materials. I think that concrete materials—being,

as they are, local in character—will be used more and more. Cement can be made all over the country, and sand and gravel can be obtained locally in most cases. Steel can be eliminated in many cases by substituting concrete.

I. L. Simmons:—We (on the Rock Island) are in rather a fortunate position this year, owing to the fact that we ordered our bridge steel about two years ago. We have all we can put in, so the material situation has not bothered us very much from the bridge standpoint. Of course, next year we may be cramped so far as structural steel is concerned, but the use of concrete on our road has cut down the amount of steel which we require. I believe that is going to be the solution of our problems, using concrete trestles and concrete boxes, and possibly going to concrete pipe where we have been using cast iron pipe.

I think the railroads will have to adjust their standards to the new condition of affairs. Some roads have not believed in concrete, but the new conditions have brought about the fact that, whether they believe in it or not, they have got to try it out. Once they have tried it out, there is no question in my mind but what they will stick to it.

We probably will not be in the market for very much bridge steel next year. We have taken out a lot of structures to prepare for heavier loading, and in the last four years we have scrapped very few. Our supply of second hand material is very large at the present time, but we are using it up by doubling up the girders wherever possible and changing old girders into new deck plate girders.

J. J. Taylor:—We are having all kinds of trouble to get material on the Kansas City Southern. I think that the solution is going to be resorting to concrete construction. On account of heavier loading we have had to take out several of our larger spans. We have not been able to dispose of them because they are not heavy enough for use elsewhere.

R. C. Young:—There is one way of conserving steel production and that is by the use of the oxy-acetylene welding apparatus whereby you can weld new gears on castings, take old bridge trestles and cut the columns up into shorter lengths, put new feet on them and use them in other structures instead of scrapping them. I had an experience in taking down a very high trestle which was too light. I came very nearly selling the material to the scrap-iron men at a very low price, but finally I

found out about the new apparatus at the last moment and I have built several smaller trestles of that very material which I intended selling to the scrap-iron men for almost nothing.

H. Gerst:—On the Great Northern all of our structural timber, such as bridge ties, comes from the coast. We use Douglas fir, and we figure all the way from three to six or seven months for the time of delivery. The market has been pretty badly demoralized the last few months, and it is hard to tell just what deliveries we can get. We get some cedar from Idaho, but that is nearly all piling. Practically all of our lumber is Douglas fir.

J. M. Staten:—Three or four years ago we had to take out a lot of light girders on account of heavy traffic, and we didn't dispose of them for scrap right away. In the last two years I think I have put in 40 or 50 spans from the stringers by putting two to the rail and using wooden braces. The structure was built for 50 ft. spans (about eight or nine of them) but we built wooden towers in the middle and put in 25 ft. stringers and the wooden braces. This makes a queer bridge but it closed up the waterway all right.

We have over 100 spans right now that we have not been able to buy steel for and we have been putting in temporary stringers and wooden braces. We have about 9 or 10 spans trussed up now, but we are trying to make them run until steel gets down where we can buy it.

The President:—There is one thing on which Mr. Simmons dwelt for a short time, and on which I have always been a crank—even when steel was cheaper and more easily available than it is now, and that is—using old spans back in the track again. In my practice I have not only installed deck plate girders again by doubling them up, but I have followed very largely the practice of shortening up truss spans and also cutting down to single-track, light, double-track spans that have been taken out. Generally, when a span is taken out, there are some particular members which are weak, and those members, if the truss could be taken down, dismantled and put together again, could be reinforced and the truss would have a carrying capacity until a very material further increase in loads should take place. It is frequently possible by cutting down the truss span (sometimes a couple of panels) to install it in the track again.

Just recently I finished a bridge across the Trinity river at Dallas where a 200 ft. span was cut down to 162 ft. Two panels were taken out of it, but the same chords, bars and the compression members were used. The work was all done in the railroad shops. When the bridge was taken down I think it had a capacity of E-35 and it went back as E-60. When it was taken out it would not carry an engine weighing 80 tons on the drivers, but when it was put back it was rated for an engine carrying 150 tons on the drivers. The cost of shortening it was only about one-quarter of the cost of a new bridge.

I had another case of a double-track span being taken out at St. Louis. The spans were given a new floor system of single-track strength and no change whatever was made in the trusses and they now rate considerably over E-60.

In the material yard of almost every railroad, up to the time that scrap got so high, could be found any number of old trusses for which the purchasing agent was trying to find a purchaser who would give from a cent to a cent and one-half a pound, and a lot of it is gone, I presume, because I have seen a lot of railroad yards which have been depleted, but those old spans could have been reinforced and remodeled at a very small percentage of the cost of a new span and put back in service. There is more reason now for that than ever before. The bridges that are being taken out now are built of good material, and they can be reinforced and changed slightly and put back with a very substantial increase in capacity.

Sometimes we find some of the diagonal members are weak and the bridge is not good. If it is taken down and shipped to one of the machine shops on the railroad and worked over a little, it can be put back and it will have a capacity of from 20 to 25 per cent in excess of its capacity when it was taken down.

L. Jutton:—I recall several cases on the Northwestern where we have worked spans over without taking them out. They were reinforced and the weaker members were strengthened by adding additional members. The work was done at a very low cost and the capacity of those bridges was changed from something like E-40 to better than E-60.

W. M. Camp:—It probably is not saying anything new, but it has even been practical to add extra flange plates to the tops and bottoms of girders for a good many years, to make them stronger.

I. L. Simmons:—There is one point which has not been brought out. Take the old lattice spans built from 1888 to 1892; probably they will not rate higher than E-42 or E-43, while a good main line bridge should rate about 55 or 60 now. If you examine those spans you will see that the direct stress will probably be taken care of all right, with the exception of the rivets. In one case I have in mind on our main line we went over all the connections, knocked out the ¾-in. rivets and put in ⅞-in. redriven. We did this at a very moderate cost and we have a bridge now over which I am perfectly safe in putting an engine weighing up to E-55 or E-56, and I do it with no hesitancy whatever.

I think that at this time, before we consider taking out a bridge or a span at all, the first thing to do is to consider what we can do with it to keep it in. In looking over your rating chart, you may find a bridge rating about an E-42 and you say, "That has to come out," but get your diagram and see what parts of it are weak, and you may be surprised at the amount of good you can do that structure at a cost of from $400 to $600. I believe it is up to every one to see what can be done to carry over structures before figuring on putting in new ones.

W. E. Alexander:—The International bridge on the Main Central at Vanceboro was first erected as a pin-connected bridge in 1888. After a while they found that it was not heavy enough for the loads they wanted to put on it. The way they strengthened that was to make duplicate trusses, placing them on the outside of the original trusses.

The President:—I will say that each particular steel bridge is a study in itself, and it is not an easy job for a bridge man to sit down with the plans of an old light span before him and say what ought to be done to that particular bridge to get it in shape. There is no doubt there are cases where duplicate trusses can be put in and connected up to work together. But it may be a question as to whether the expense required in that connection would be justified.

Old bridge spans were built for certain types of engines. If the old engines and cars had increased in the same proportion in length as to weight, and if every member in the bridge had been designed exactly right in the first place, every part of the bridge would reach its maximum strength at the same time. But we often find in a bridge that perhaps 5 out of 25 members would

be stressed up to the limit of safety and the others might have many points of strength left in them. It is impossible to give a general answer as to whether duplicate trusses can be put in beside the others and make it a practical, as well as an economical proposition.

Now to get off of steel bridges and come to trestles. Down in the southwest they are very prodigal of timber, and they do it because it comes to them easy. They go in and drive piles because some of them are rotting off at the ground line. This is one of the worst wastes of material that I know of. There are so many ways in which that material can be conserved and saved. Let us consider a pile 40 ft. long that is half out and half below the ground. There is a section of about 4 ft. right in the center of that pile that must be thrown away, but the other 18 ft. below and the 18 ft. above the ground are still pretty nearly as good as when placed in service. We should find out how best to protect those piles at the ground line. There are many bridges built up to 10 years ago that can still be protected by some sort of a preservative coating. Boxes of salt might be put around them at the ground line, or they might be sunk into the ground a little.

Those are the stunts I think it is particularly valuable to follow at the present time. If some of you gentlemen who know so much more about it than I do will get up and tell about them it will be a valuable aid to us all.

H. von Schrenk:—It might be of interest to know of something I personally tried on half a dozen bridges with salt boxes. We had several trestles down in Louisiana built of rather sappy pine piling. We did not have the money to put in new ones just then, and those that were in looked as if they should serve for a time, so we had some shallow boxes built immediately. The boxes extended out from the piles possibly 4 or 5 in., care being taken so that the bottom of the box did not fit too closely around the pile. Then we ran a handcar full of rock salt over the bridge and simply shoveled the boxes full. Every time it rained some of the salt would dissolve and run down beside the pile and stick there, finally drying and turning hard, so that after three or four rains the piles were practically like alabaster. We thought the ordinary length of time those piles would last could not be more than five or six years, but they are just as hard as stone today after 5 years' service. I don't remember the exact cost, but

it was so small as to be almost insignificant. This last year I have been planning to put the same kind of work on some old trestles, which show decay, and I think we can make the piles last several years longer. Those piles are five years old at this time, and we probably would have had to replace them twice over if we had not adopted this expedient.

INTELLIGENT RECLAMATION OF MATERIAL

By C. A. Lichty, Chicago & Northwestern Railway

The best materials are used in the construction and maintenance of railway bridges and buildings. Every employee of the bridge and building department should exercise his best judgment in the intelligent reclamation of the various materials used in his department. Good second-hand bridge timbers were often disposed of in by-gone days in a reckless manner. They were commonly used for backwalls in pile bridges, retaining walls, foundations, platforms, culverts, runways, sidewalks, etc., while pile heads and second-hand piling were in many cases burned, cast aside or given away. Many roads have in recent years built small mills which are equipped with inserted tooth saws for resawing and working up old bridge timbers into all kinds of good usable material. Old stringers with decayed ends have been worked up into lumber entirely fit for interior finish; new elm and maple pile heads can be sawed and turned into jack and cant hook handles; oak heads can be sawed into car stakes, ballast stakes, etc., while cedar heads can be sawed into shingles, as good as any wooden shingle on the market.

The saw mill is not only useful for the working up of second-hand material, but it is very convenient for resawing all of the odd-sized lumber that is left over from the construction of buildings. Every material yard accumulates more or less new lumber of odd sizes, awaiting its turn perhaps for years before it can be used to advantage; while with the use of the small mill it can at once be converted into sizes that are suitable for immediate use. Old buildings replaced with new structures, if not used elsewhere, should be torn down and all of the good material used for repairs or wherever it will work in to the best advantage.

Iron bridges can in many cases be rebuilt or reinforced and put into shape to be placed back in the main line or at least on some of the branch lines of a railroad where they will be of service for many years more. Those too light for railway traffic may be used for overhead highway bridges, etc.

Care should be exercised to see that the reclamation of old materials is not carried to the extreme or going beyond the economical limit. Many roads insist on the practice of keeping materials well picked up and properly taken care of, and in going to a reasonable limit in re-using good second-hand material wherever practical. There can be no question but that the reclamation of material can be made to pay large returns if properly handled and more than ordinary attention should be paid to this item during the present time when it is not only difficult to get new material but more difficult to get it over the road.

Most of the railroads are going into the reclamation of material on a large scale. While the locksmith, the blacksmith and others have —in a sense—been engaged in the reclamation of tools and materials on a small scale for a long time, the roads are now going into it to the extent of erecting separate shops for the purpose—equipped with special machinery, thereby working over at a small cost material which takes the place of new but which formerly may have gone into the scrap pile.

DISCUSSION

The Secretary:—Some of the railroad journals have published a considerable amount of information during the past year on the reclamation of materials, and a good paper might well be made up from those articles. The Railway Maintenance published quite a number of articles on that subject within the past 10 or 12 months.

I have made a study of the reclamation of materials on the Chicago & Northwestern and I am positive that we can make it pay. We have a mill at Boone, Ia., where we saw up hundreds of carloads of good second-hand material into lumber of every description, from track shims and slope stakes up to the heaviest timbers used in buildings. During the past year we built a large elevator where long leaf yellow pine piles were used for the foundation. On account of difficult driving many of the pile heads ran in lengths varying from 6 to 15 ft. We had several carloads of this material and with the sawmill not far distant, we promptly sawed these heads into the best kind of lumber, and it was all utilized. I have seen the time when all or most of this class of material went to waste because we had no convenient method of working it up.

Mr. Knowles, in his paper, tells us how to reclaim materials in the water supply department. The water supply men are always using and re-using second-hand material; we all know how difficult it is to get material in their line, and what it costs when we are able to get it.

One of our members (E. R. Lewis, D. S. S. & A. R. R.) had an article in the Maintenance Engineer several months ago where he took exception to the attempts to conserve old material without considerable study of the question. He thought it inadvisable to try to reclaim some of the old material, saying it would cost more to handle it and put it into use than it was worth. This is true in some cases, no doubt, but I will cite an instance of an experinece I once had on the Northwestern. I was engaged in having scrap and usable material of all kinds gathered up, assorted and sent in (if not suitable for use in the same locality). Upon calling the attention of the division superintendent to the condition of things after a partial pick-up had been made he said, "I believe it does not pay to bother with such stuff; far better leave it alone and let the men work at

something else,—but you go ahead and after one hour's work let me know what is a fair estimate of the value of the material picked up." The material was picked up, much of it only scrap, but a great deal was as good as new. A fair estimate showed the value to be between $60 and $70. The superintendent decided that it would be a good plan to have a general clean-up made and it resulted in a number of carloads of material of all kinds valued at thousands of dollars. Of course pick-ups of such magnitude might not occur now, for we keep after such material all the time,—and it pays to do it.

Mr. Howson is pretty well versed in this matter and I believe he can say a few words to us on this subject that would be interesting.

E. T. Howson:—I am sure that there is no man here who does not realize the importance of reclaiming materials under present conditions. It is not alone a question of economy, but in many cases it is one of providing ourselves with materials through that source when they are not available otherwise.

The reference made by Mr. Lichty to the point originally raised by Mr. Lewis, touches a subject which I think is a most vital one. It don't pay to spend $2 to save $1 worth of material. Yet, under present conditions we should be careful not to use the old estimates. Material that was worth a dollar a year ago is very probably worth two or three dollars now. We have practically got to revise all of our estimates to know just where we stand with reference to the economical limits to which we can go.

Dr. von Schrenk spoke a few moments ago of the wasteful habits that have grown up, particularly in the use of timber, but also in the use of other materials, owing to their availability. It is only in the last five or six years that the railways have begun to take notice of the scrap pile, and those that have been foremost in going through their scrap piles have made tremendous savings. There is a danger of overdoing it, but in nine cases out of ten, the loss at present is not from overdoing it but from neglecting it. Under present conditions the scrap pile offers large opportunities for culling over in order to get the materials to tide us over. Mr. Simmons and others have spoken of that. I think they have given instances that do not need any other amplification. Mr. Knowles' experience of digging up the water pipe is another instance.

When you go to look for materials it is really surprising what you will find. I recall an instance where the general manager of a western railroad started out to check up his track materials a few years ago. He personally looked around the property and at one point he found 155 kegs of track spikes under a section foreman's tool house. When they had finished laying rails the year before the foreman had grabbed the spikes and thrown them under there to get them out of the way.

G. W. Andrews:—For the last 15 years we have been studying the question of the conservation of material, and this subject has grown more extensive each year. As probably most of you know, our president, Mr. Willard, has been taking an exceptionally active part in the National Council of Defense at Washington and he has been preaching conservation to us to such an extent that sometimes we feel that our names begin with a C. We have made, and are making, studies of conservation in almost every line of materials in which railroads have to deal, and if you will bear with me just a few moments, I will endeavor to tell you some of the important things we have worked on.

Within the last six or seven years we have been required to renew many of our structures on the main line territory to provide for heavier power which has grown so rapidly that the bridges became entirely too light; we had to strengthen them at every conceivable point to take care of the weak members, and it was found necessary to renew many of them with heavier and more modern structures.

In the beginning many of the structures were scrapped, but it was finally decided that no girder spans should be scrapped and that the truss spans should be kept as well. Within the last five years we have built a number of new lines in the coal territory in which every bridge entering into the construction of the new lines has been made of structures that were taken out of main line territory, strengthened and shortened. In some instances double track through spans have been reduced to single track spans, or double track through girders reduced to single track girders, or the floor systems taken out and deck girders made of them. In all cases this work has been done at a price far below the purchase price of new structures at that time. When we found some of the girders which were entirely too light even for branch line territory, and where it was not advisable to double them up, we scrapped them, but we have now

discontinued that, and we are now cutting them up with the oxy-acetylene torch and reclaiming every part that it is possible to use again for any purpose whatever. We have our own bridge shop which enables us to do this work with a great deal of facility and in considerably less time than we could have done elsewhere. In these shops we build bridges of a type that it would be almost impossible to get the contracting bridge companies to consider. We do not throw away frogs under any circumstances. They go to our maintenance shops at Martinsburg, where they are cut up and every part that is fit for use enters into the construction of new frogs. We are turning out now close to 500 frogs a month, most of them having parts of the old frogs in them. It is the same with the switches. We reduce the long switch point to a shorter length. Very often the switch is good for the entire length, but the point is snubbed off, so that is cut down to a shorter length.

Formerly we burned all of our old wooden cars, but that practice has been discontinued. We have put in a reclaiming plant at Zanesville, where most of the wooden cars are dismantled, or the old material is sent to Zanesville where it is sawed up in the right sizes to use in building construction for cars. The rods are sent to the system shop in Baltimore and rerolled. We don't use any of these reclaimed rods in bridge work, but we do use them for bolts of every character. Only last week I was in the reclaiming mill and I found that they had, at that time, something like 50 tons of reclaimed rods that formerly went into scrap iron.

Until a very few years ago it was the custom of our divisions to scrap the old pumps. The repair shop would decide it could not do anything with them and they would go into the scrap heap. We took the matter in hand and had the pumps shipped to our Martinsburg shops, since which time (about 5 years), we have not purchased a new steam pump.

We have scrap yards located at Baltimore, Glenwood and Pittsburgh, where all material is first separated and assorted, and every dollar's worth of material that is of value is collected and sent to one of the reclaiming shops where it is put in shape for future use. We feel that in doing this we are not only conserving material, but that we are saving money, even based on the material, at former prices. At the present abnormal prices we are making a fortune for the company every day.

In pipe work we have found a number of cases similar to those Mr. Knowles has described, and in every case that I can recall every piece of pipe of value was reclaimed and used in some other point. We have practically eliminated the use of cast iron pipe for drainage sewers or culverts, and have substituted concrete pipe, which we make of our own design. We are making three sizes, 24 in. 36 in. and 48 in., and we make it for just about one-half the cost if we purchased it.

Some years ago we were purchasing a 50,000 gal. water tank with cypress staves for about $275. To-day it costs $850. We have used methods to save the old tanks to the last moment. We have saved many tanks that in 1902 were declared to be absolutely unfit for service and they are still in service. We simply put in from 4 to 6 in. of fine concrete, made in the proportions of one, three and five, the stone being not more than 1½ in. in diameter wherever possible. I say stone, because we get that from our quarry, but where it is not economical to ship from the quarries we do use gravel. The concrete is placed and then we place two or three additional hoops around the bottom of the tanks. In cases where decay or holes have developed in the staves above that point we clamp a piece of two or three-inch timber, well saturated with coal tar, on the inside. Where the decay is so great we have even put struts across the tank to hold the clamps in place. In many cases where the decay is small we simply put it in with the wood clamp.

We are showing a constant increase in economy in our methods, and, while we think we have this work well in hand, we have not stopped. We are going further in every line. We are at this moment installing a saw in the reclaiming yard at Baltimore, where old bridge ties, stringers, and bridge timbers of all kinds will be sent and sawed up into planks or scantlings. As most of us know, the first decay in a stringer shows at the end resting on the caps. Very often a length of 10 or 12 ft. of the center of the stringer is good. Sometimes it is decayed on top, but if it is a 16-in. stringer there will often be 12-in. of good timber from the bottom up, exclusive of the ends. We expect that the saving in the sawing of that material will almost meet our demand for material for small buildings, etc.

Mr. Brantner:—Mr. Andrews has not yet referred to the actual results and costs. I will state that on all turntables, bridge

girders, etc., a credit of $22 a ton is allowed to the division from which they come. This enters into the first cost of remanufacturing or remodeling the bridge-girders or turntables. The application of the new material and the labor on the bridges we are turning out are costing from 1½ to 2½ cents.

I will refer to a turntable condemned in 1910 as being unfit for service, which Mr. Andrews inspected and decided could be remodeled. It was sent to our shop where we removed the corroded angles and the cover plates and cut out the bad rivets, put in new material, reinforced it in certain spots, put in additional angles and put the turntable back into service in April, 1911, at a cost of $700. That turntable is still in service to-day, turning the largest engines.

Mr. Markley:—I would like to inquire what the original length of that turntable was.

Answer: Seventy feet.

The President:—I would like to speak of some turntables which I have extended on the Texas & Pacific. In one instance a longer table was needed where a 60-ft. table was in, and in another instance a 75-ft. table had to be lengthened. In the case of the 75-ft. table a longer table had to be put in to turn the new engines, so the old 75-ft. table was taken out and extended to 85 ft. and put back again. The wheels were left in the same place and the circle in the same radius, and that table has been in nearly a year now and is doing the work all right.

On the Missouri Pacific I extended a good many of those tables and they are all in use to-day. The cost of extending them is very nominal and a very great saving can be effected by extending 60 and 75-ft. turntables. And you have the additional advantage that they fit the old centers, and you can sometimes extend them in the same pits; you can just extend the circle and put the table right back in the place of the shorter one.

Mr. Andrews mentioned bridge stringers. I think a number of you gentlemen will take issue with me that the best place for a bridge stringer which costs a small fortune now-a-days is under the ties and not to be put down for a dump plank or to make a footing here and there; nothing breaks my heart more than to see a good bridge stringer cut down and put in as a dump plank, when perhaps only two or three per cent of that stringer had served its usefulness. And it would pay better

to make concrete blocks of the same size to be used as footing blocks than to use a costly bridge stringer.

It occurs to me that the life of the stringers in the first place can be extended by perhaps dropping salt down where the stringers join the cap and help preserve it that way, and after the stringers do have to come out there are a lot of better things to use them for than dump planks. It is better in many cases to buy new material for dump planks than to use the stringers that come out.

J. P. Wood:—On all of our new work at the present time on which we use plain timber, where the stringers come together at the ends, where they rest on the caps and where the caps rest upon the piling, we are painting them with creosote oil as a precaution against decay.

The President:—Mr. Ettinger, will you tell us something about the present situation as to paint and oils?

C. Ettinger:—While it may sound queer, it is a fact that the paint market is not suffering to-day to the extent that the rest of the markets in the supplies necessary to carry on the railroad business are. Paint has only increased in price from 8 to perhaps 14 per cent, with the exception of some very high-class articles, and they can be left alone at this time. Our greatest trouble now is with labor. Most of the floating gangs doing painting work, high stage work, and the like, require young, active men. Nearly all of them are within the draft ages.

One difficulty at the outset of the war was the securing of durable colors needed for targets, etc., but the chemists of this country are fast getting up to the point now where they can equal the fellow on the other side of the ocean.

Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Colo.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428
21	St. Louis, Mo.,	Oct. 17-19, 1911	499
22	Baltimore, Md.,	Oct. 15-17, 1912	524
23	Montreal, Que.,	Oct. 21-23, 1913	570
24	Los Angeles, Cal.,	Oct. 20-22, 1914	586
25	Detroit, Mich.,	Oct. 19-21, 1915	665
26	New Orleans, La.,	Oct. 17-19, 1916	710
27	Chicago, Ill.,	Oct. 16-18, 1917	704

	1891-2.	1892-3.	1893-4.	1894-5.

	1895-6.	1896-7.	1897-8.	1898-9.
President	W. A. McGonagl	J	G. Berg....	J. H. Cummin.
1st. V.-Pres. .	L. K. Spafford	\	Cummin....	A. S. Markley.
2nd. V.-Pres.	James Stannard.	J	Markley....	C. C. Mallard.
3rd. V.-Pres.	Walter G. Berg.	A	Hinman....	W. A. Rogers.
4th. V.-Pres. .	J. H. Cummin.	I	Mallard.....	I. M. Staten.
Secretary	S. F. Patterson.	S	'atterson....	S. F. Patterson.
Treasurer	George M. Reid	N	Thompson..	\ W Thompson
Executive Members .	R. M. Peck....	\	Bishop......	Wm. S. Danes.
	J. L. White...	\	Austin......	J. H. Markley.
	A. Shane	J	ey	W. O. Eggleston
	A. S. Markley.	C	. Danes....	R. L. Heflin.
	W. M. Noon...	C	Markley....	F. W. Tanner.
	J. M. Staten...	M	Eggleston.	\. Zimmerman.

	1899-1900.	1900-1901.	1901-1902.	1902-1903.
President ..		V. A. Rogers...	W. S. Danes.....	B. F. Pickering.
1st. V.-Pres.		V. S. Danes....	B. F. Pickering..	C. C. Mallard.
2nd. V.-Pres.		t. F. Pickering.	A. Shane	A. Shane.
3rd. V.-Pres.		. Shane.......	A. Zimmerman ..	A. Zimmerman.
4th. V.-Pres.		. Zimmerman .	C. C. Mallard....	A. Montzheimer
Secretary ..		. F. Patterson.	S. F. Patterson..	S. F. Patterson.
Treasurer ..		I. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members .		. M. Strain....	A. Montzheimer..	W. E. Smith.
		I. D. Cleaveland.	W. E. Smith.....	A. W. Merrick.
		W Tanner..	A. W. Merrick...	C. P. Austin.
		Montzheimer.	C. P. Austin.....	C. A Lichty.
		V. E. Smith....	C. A. Lichty....	W O Eggleston
		. W. Merrick..	W O Eggleston	J H Markley

	1903-1904.	1904 1905.	1905-1906.	1906-1907
President	A. Montzheimer..	C. A. Lichty...	J. B. Sheldon...	J. H. Markley.
1st. V.-Pres. .	A. Shane	J. B. Sheldon..	J. H. Markley...	R. H. Reid.
2nd. V.-Pres.	C. A. Lichty....	J. H. Markley..	R. H. Reid	J. P. Canty.
3rd. V.-Pres.	J. B. Sheldon...	R. H. Reid.....	R. C. Sattley....	H. Rettinghouse.
4th. V.-Pres. .	J. H. Markley...	R. C. Sattley...	J. P. Canty......	F. E. Schall.
Secretary	S. F. Patterson..	S. F. Patterson..	S. F. Patterson.	S. F. Patterson.
Treasurer ...	C. P. Austin....	C. P. Austin....	C. P. Austin.....	C. P. Austin.
Executive Members .	R. H. Reid......	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam....	A. E. Killam.....	A. E. Killam
	A. E. Killam ...	H. Rettinghouse.	J. S. Lemond....	J. S. Lemond.
	R. C. Sattley....	J. S. Lemond...	C. W. Richey....	C. W. Richey
	H. Rettinghouse..	W. H. Finley..	H. H. Eggleston.	H. H. Eggleston
	J. S. Lemond ...	C. W. Richey...	F. E. Schall....	R. J. Sweett

	1907-1908.	1908-1909.	1909-1910.	1910-1911.
President	R. H. Reid	J. P. Canty	J. S. Lemond	H. Rettinghouse
1st. V.-Pres.	J. P. Canty	H. Rettinghouse	H. Rettinghouse	F. E. Schall
2nd. V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd. V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th. V.-Pres.	W. O. Eggleston	A. E. Killam	J. N [illegible] vell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A [illegible] y	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. F [illegible] y	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. [illegible]	T. J. Fullem
	J. S Lemond	Willard Beahan	F. I [illegible] etz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. I [illegible] ven	P. Swenson
	T. S. Leake	W. H. Finley	T. J [illegible] n	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. [illegible]	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. [illegible]	W. F. Steffens

	1911-1912.	1912-1913.	1913-1914.	1914-1915.
President	P [illegible]	[illegible]	[illegible]	[illegible]
1st. V.-Pres.	A [illegible]	[illegible]	[illegible]	[illegible]
2nd. V.-Pres.	J. [illegible]	[illegible]	[illegible]	[illegible]
3rd. V.-Pres.	L [illegible]	[illegible]	[illegible]	[illegible]
4th. V.-Pres.	T [illegible]	[illegible]	[illegible]	[illegible]
Secretary	C [illegible]	[illegible]	[illegible]	[illegible]
Treasurer	J. [illegible]	[illegible]	[illegible]	[illegible]
Executive Members	G [illegible]	[illegible]	[illegible]	[illegible]
	P [illegible]	[illegible]	[illegible]	[illegible]
	G [illegible]	[illegible]	[illegible]	[illegible]
	W [illegible]	[illegible]	[illegible]	[illegible]
	F [illegible]	[illegible]	[illegible]	[illegible]
	W [illegible] or	[illegible]	[illegible]	[illegible]

	1915-1916	1916-1917	1917-1918
President	G. W. Rear	[illegible]	S. C. Tanner
1st. V.-Pres.	C. E. Smith	[illegible]	Lee Jutton
2nd V.-Pres.	E. B. Ashby	[illegible]	F. E. Weise
3rd V.-Pres.	S. C. Tanner	[illegible]	W. F. Strouse
4th V.-Pres.	Lee Jutton	[illegible]	C. R Knowles
Sec.-Treas.	C. A. Lichty	[illegible]	C. A Lichty
Executive Members	F. E. Weise	[illegible] e	A. Ridgway
	W. F. Strouse	[illegible] es	J. S. Robinson
	C. R. Knowles	[illegible]	J. P. Wood
	A. Ridgway	[illegible] on	D. C. Zook
	J. S. Robinson	[illegible]	A. B. McVay
	J. P. Wood	[illegible]	J. H. Johnston

CONSTITUTION *

ARTICLE I.

NAME.

Section 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

Section 1. The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussions, providing a medium for the exchange of ideas to the end that bridge and building practice may be systematized and improved.

Section 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP.

Section 1. The membership of this association shall be divided into two classes—active and life members.

Section 2. To be eligible for active membership, a person must be actively employed in railway service in responsible charge of the design, construction or maintenance of railway bridges, buildings or other structures; a professor of engineering in a college or university of recognized standing; an engineering editor, or a government or private timber expert

Section 3. To be eligible for life membership a person must have been a member of the association for at least five years and in general must have retired from active railway service. The association, however, may waive the latter condition by a majority vote of the members at a regular session for good and sufficient reasons. A life member shall have all the privileges of active membership and shall not be required to pay annual dues.

Section 4. Any member guilty of conduct unbecoming a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, may forfeit his membership on a two-thirds vote of the members present at any regular session of the association.

Section 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

* Revised October, 1914. Amended October, 1915.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary-treasurer and six executive members, all of whom shall constitute the executive committee.

SECTION 2. The past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECTION 3. Vacancies in any office for the unexpired term shall be filled by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial interests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECTION 2. Two-thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECTION 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association which convenes on the third Tuesday in October, and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

SECTION 2. The president, four vice-presidents and secretary-treasurer shall hold office for one year and the executive members for two years, three being elected each year. All officers will retain their offices until their successors are elected and installed.

SECTION 3. The term of office of the secretary-treasurer may be terminated at any time by a two-thirds vote of the executive committee. His compensation shall be fixed by a majority vote of the executive committee. The secretary-treasurer shall also serve as secretary of the executive committee.

SECTION 4. The secretary-treasurer shall be required to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

ANNUAL DUES.

SECTION 1. Every member upon joining the association shall pay to the secretary-treasurer three dollars membership fee and two dollars per year in advance for annual dues. No member one year in arrears for dues shall be entitled to vote at any election, and any member more than one year in arrears shall be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least sixty days previous to said regular meeting.

BY-LAWS*

TIME OF MEETING.

1. The regular meeting of this association shall convene annually on the third Tuesday in October at 10 a. m.

PLACE OF MEETING.

2. Places of holding the next annual convention may be proposed at any regular session of the association. All the places proposed shall be submitted to a ballot vote of the members present at the annual business session and the place receiving a majority of all votes cast shall be declared the location of the next annual meeting. If no place receives a majority of the votes cast, the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

3. It shall lie within the power of the executive committee to change the location of the meeting place if it becomes apparent that it is for the best interests of the association.

QUORUM.

4. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

DUTIES OF OFFICERS.

5. The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall,

* Revised October, 1914. Amended October, 1915.

with the secretary-treasurer, sign all contracts or other written obligations of the association which have been approved by the executive committee. At the annual meetting the president shall present a report containing a statement of the general condition of the association.

6. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

7. It shall be the duty of the secretary-treasurer to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

NOMINATING COMMITTEE.

8. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, which shall prepare a list of names of nominees for officers to be voted on at the next annual convention, in accordance with Article VI of the constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE.

9. At the first session of each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary-treasurer and certify as to the correctness of his accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

COMMITTEE ON SUBJECTS FOR DISCUSSION.

10. After the annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEES ON INVESTIGATION.

11. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE.

12. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS.

13. 1st—Registration of members.
2nd—Reading minutes of the last meeting.
3rd—Admission of new members.
4th—President's address.
5th—Report of secretary-treasurer.
6th—Payment of annual dues.
7th—Appointment of special committees.
8th—Reports of standing committees.
9th—Unfinished business.
10th—New business.
11th—Election of officers and selection of place for holding next annual meeting.
12th—Installation of officers.
13th—Adjournment.

(Report of nominating committee to be read at first session of second day—Section 9 of By-Laws.)

DECISIONS.

14. The votes of a majority of the members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

15. All discussions shall be governed by Robert's rules of order.

DIRECTORY OF MEMBERS

Aagaard, P., Chief Inspector, I. C. R. R., Chicago.
Ailes, N. C., Asst. Val. Engr., D. & H. Co., Albany, N. Y.
Airmet, E. S., For. Ptr., O. S. L. R. R., Salt Lake City.
Alexander, W. E., Supt. B. and B., B. & A. R. R., Houlton, Me.
Allard, E. E., For. B. & B., Mo. Pac. Ry., St. Louis.
Allen, T. H., Supv. B. & B., C. & O. Ry., Hinton, W. Va.
Althof, L. W., Asst. Maint. Engr., U. P. R. R., Omaha, Neb.
Anderson, August, Gen'l For. B. and B., L. S. & I. Ry., Marquette, Mich.
Anderson, L. J., For. B. and B., C. & N. W. Ry., Escanaba, Mich.
Andrews, G. W., Asst. to Eng. M. of W., B. & O. R. R., Baltimore, Md.
Andrews, T. O., Ind. & Frankfort R. R., Lebanon, Ind.
Archbold, H. L., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
Arey, R. J., 541 So. Cummings St., Los Angeles, Cal.
Ashby, E. B., Consulting Engr., L. V. R. R., New York City.
Ashmore, A. B., Supv. B. & B., M. L. & T. Co., Lafayette, La.
Ashton, D. H., Asst. Engr., L. A. & S. L. R. R., Salt Lake City.
Auge, E. J., Chief Carp., C. M. & St. P. Ry., Wells, Minn.
Austin, C. P., 107 Park St., Medford, Mass.

Bach, C. F., For. B. & B., C. & N. W. Ry., Belle Plaine, Iowa.
Bailey, F. W., Supt. M. of W., S. A. & A. P. Ry., Yoakum, Tex.
Bailey, S. D., M. C. R. R., Detroit, Mich.
Ball, E. E., Div. Engr., A. T. & S. F. Ry., Fresno, Cal.
Ballard, C. F., Carp. For., S. A. L. Ry., Peachland, N. C.
Baluss, F. C., Engr. B. & B., D. M. & N. Ry., Duluth, Minn.
***Barber, N. N.,** Stone & Webster Eng. Corp., Rock Island, Ill.
Barger, T. R., For. B. & B., L. & N. W. R. R., Homer, La.
Barnes, O. F., Div. Engr., Erie R. R., Jersey City, N. J.
Barrett, E. K., Supvr. B. and B., F. E. C. Ry., St. Augustine, Fla.
Barrett, J. E., Supt. of Track, B. and B., L. & H. R. Ry., Warwick, N. Y
Barry, E. J., Bldg. Insp., D. L. & W. R. R., Hoboken, N. J.
Barton, M. M., 311 No. 34th St., Philadelphia, Pa.
Bates, Onward, Civil Engineer, McCormick Bldg., Chicago.
Beal, F. D., 800 Fife Bldg., San Francisco, Cal.
Bean, C. C., Contractor, 243 Benton St., Freeport, Ill.
Beard, A. H., 705 No. 11th St., Reading, Pa.
Beckman, B. F., Engr., F. S. & W. R. R., Fort Smith, Ark.
Beeler, C. L., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
Beeson, R. W., Div. For. B. and B., C. & S. Ry., Trinidad, Colo.
Bender, Henry, For. B. & B., C. & N. W. Ry., Eagle Grove, Ia.
Benz, F. A., Div. Engr., B. R. & P. Ry., E. Salamanca, N. Y.
Berry, J. S., Supt. B. and B., S. L. S. W. Ry., St. Louis, Mo.
Bibb, J. M., Supvr. B. and B., L. & N. R. R., Birmingham, Ala.
Bigelow, F. M., Supv. B. & B., L. A. & S. L. R. R., Salt Lake City.
Bishop, McClellan, Mast. Carp., C. R. I. & P. Ry., El Reno, Okla
Bishop, R. R., For. B. and B., L. A. & S. L. R. R., Salt Lake City.
Black, G. W., Supt. McGrath Sand & Gravel Co., Pekin, Ill.

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*In the National Service.

Black, J. D., Supvr. B. and B., P. M. R. R., Saginaw, Mich.
Blake, L. M., Supv. B. & B., B. & M. R. R., St. Johnsbury, Vt.
Blowers, S. H., For. Carp., B. & O. R. R., Columbus, O.
Bock, J. G., Gen. Br. Insp., C. St. P. M. & O. Ry., St. Paul, Minn.
Bohland, J. A., Br. Engr., G. N. Ry., St. Paul, Minn.
Bonner, J. K., Asst. Supvr. B. & B., N. Y. C. R. R., Rochester, N. Y.
Bourgeois, F. J., Supv. B. & B., N. O. G. N. R. R., Bogalusa, La.
Bouton, W. S., Engr. of Bridges, B. & O. R. R., Baltimore Md.
Bowers, Stanton, Mast. Carp., P. C. C. & St. L. Ry., Bradford, O.
Bowers, S. C., Mast. Carp. of Brdgs., P. C. C. & St. L. Ry., Steubenville. O
Bowman, R. M., Hw. Engr., Office of Public Roads, Washington, D. C.
Boyd, G. E., Div. Engr., D. L. & W. R. R., Buffalo, N. Y.
Boyer, Grant, Div. For. B. & B., M. C. R. R., Detroit, Mich.
Brantner, Z. T., Supt. M. of W. Shops, B. & O. R. R., Martinsburg, W. Va.
Bratten, T. W., Supvr., B. and B., S. P. Co., Oakland Pier, Cal.
Brewer, W. A., Asst. Engr., I. C. C., 914 Karpen Bldg., Chicago.
Bricker, H. R., Inspr. M. of W., B. & O. R. R., Baltimore, Md.
Bridges, T. H., Asst. For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Briggs, B. A., 311 E. Cache la Paudre St., Colorado Springs, Colo.
Brookhart, N. D., Supv. B. & B., O. S. L. R. R., Pocatello, Idaho.
Brooks, G. E., Mast. Carp., C. R. I & P. Ry., Rock Island, Ill.
Brown, Alf., B. & B. Inspr., P. E. Ry., Los Angeles, Cal.
Brown, C. W., Sou. Pac. Co., Mina, Nevada.
Brown, E. H., Supv. B. & B., N. P. Ry., Minneapolis, Minn.
Brown, Thos., Br. Inspr., P. M. R. R., Saginaw, Mich.
Browne, J. B., Gen'l For. B. and B., K. C. C. & S. Ry., Clinton, Mo.
Browne, J. S., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn
Bruce, R. J., Genl. Bldg. Inspr., Mo. Pac. Ry., St. Louis, Mo.
Buck, A. J., Chief Carpenter, C. M. & St. P. Ry., Tacoma, Wash.
Buckley, J. E., Supvr. B. & B., B. & M. R. R., Nashua, N. H.
Bulger, Hugh, For. B. & B., Sou. Pac. Co., Oakland Pier, Cal.
Burckhalter, F. L., Supt. Sou. Pac. Co., Portland, Ore.
Burgess, W. H., Supvr. B. & B., Sou. Pac. Co., Stockton, Cal.
Burke, Daniel, Supvr. B. and B., Sou. Pac. Co., Tucson, Ariz.
Burnett, W. L., For. B. & B., St. L. I. M. & S. Ry., Eudora, Ark
Burns, W. E., Asst. Eng., S. P. Co., San Francisco (care of G. W. Rear).
Burpee, Moses, Chief Engr., B. & A. R. R., Houlton, Maine.
Burrell, F. L., Gen'l For. B. and B., C. & N. W. Ry., Fremont, Neb.
Byrd, J. E., Asst. For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Byrd, L. J., For. B. & B., St. L. I. M. & S. Ry., Dermott, Ark.
Byrd, W. E., Asst. For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.

Cahill, E., Genl. For. B. & B., D. L. & W. R. R., Scranton, Pa.
Caldwell, J. M., Insp. B. and B., C. I. & L. Ry., Lafayette, Ind.
Caldwell, J. T., For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Camp, W. M., Editor, Railway Review, Chicago, Ill.
Candee, Eldridge E., Sup B & B, N Y N H &HRR, New London, Conn
Candee, Elliot E., Dist. Br. For., N Y N H & H R R, Waterbury, Conn.
Canty, J. P., Supvr. B. and B., B. & M. R. R., Fitchburg, Mass.
Cardwell, W. M., Mast. Carp., W. T. Co., Washington, D. C.
Carmichael, Wm., St. J. & G. I. R. R., St. Joseph, Mo.
Carpenter, J. T., 1101 Upper 3rd St., Evansville, Ind.
Cary, E. L., Richmond, Mo.
Case, F. M., For. W. S., C. & N. W. Ry., Belle Plaine, Ia.
Casey, W. W., For. B. & B., K. C. S. Ry., Texarkana, Texas.
Catchot, A. J., Supvr. B. & B., L. & N. R. R., Ocean Springs, Miss.
Cayley, W., Supvr., G. T. Ry., Stratford, Ont.
Clark, H. W., Supv. B. & B., Mo. Pac. R. R., Atchison, Kans.
Clark, J. H., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
Clark, W. A., Chief Engr., D. & I. R. R. R., Duluth, Minn.
Clopton, A. S., Supvr. B. & B., M. K. & T. Ry., Oklahoma City, Okla.

Clothier, E. E., Chief Carp., C. M. & St. P. Ry., Mobridge, So. Dak.
Coffin, S. P., Supv. B. & B., B. & M. R. R., Charlestown, Mass.
Collings, Edwd., Chief Carp., C. M. & St. P. Ry., Perry, Iowa.
Cole, J. E., Gen'l Inspr., Sou. N. E. Ry., Providence, R. I.
Conn, F. J., Supvr. B. & B., C. N. O. & T. P. Ry., Lexington, Ky.
Cooper, H. A., Roadmaster, T. I. Ry., Gananoque, Ont.
Copland, A. C., Office Engr., C. & O. Ry., Richmond, Va.
Copp, J. P., 2626 Bond Ave., E. St. Louis, Ill. (Roberts & Schæffer Co.)
Corbin, W. S., For. B. and B., Sou. Pac. Co., San Pedro, Cal.
Corey, S. T., Ch. Dftsman, Br. Dept., C. R. I. & P. Ry., Chicago
Cota, G. M., Ch. Clerk, Eng. Dept., C. Vt. Ry., St. Albans, Vt.
Counts, D. E., Supv. B. & B., W. & A. R. R., Dalton, Ga.
Cowsert, L. A., Supv. W. S., C. N. O. & T. P. Ry., Danville, Ky.
Crawford, J. A., B. & B. Master, C. N. Ry., Saskatoon, Sask.
Crites, G. S., Asst. Engr., B. & O. R. R., Baltimore, Md.
Cronin, Jno., For. B. & B., C. & N. W. Ry., Winona, Minn.
Crosman, D. M., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
Cullen, F. P., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Cullen, J. F., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Cummin, Joseph H., Brightwaters, N. Y.
Cunningham, A. O., Chief Engr., Wabash R. R., St. Louis, Mo.
Curtin, William, Contractor, Govan, Saskatchewan.

Dale, Chas., For. W. S., I. C. R. R., New Orleans, La.
Dalstrom, O. F., Bridge Engr., C. & N. W. Ry., Chicago.
Danes, E. C., Gen. For., Wabash R. R., Peru, Ind.
Danes, W. S., Engr. M. of W., Wabash R. R., Peru, Ind.
Decker, H. H., Contractor, 2915 Ingersoll Ave., Des Moines, Ia.
Degnan, L. V., 1834 Hearst Ave., Berkeley, Cal.
Demars, E. A., G. F. Plumb. & W. S., O. S. L. R. R., Salt Lake City.
Derr, W. L., Supt., C. G. W. R. R., Clarion, Iowa.
Dickerson, O. H., Prin. Asst. Engr., D. & I. R. R. R., Duluth, Minn.
Dickson, Geo., For. Brdgs., Sou. Pac. Co., Oakland, Cal.
Dickson, G. H., Asst. Engr., B. & B., T. & N. O., Ry., North Bay, Ont.
Dittmar, F. C., Br. For., Sou. Pac. Co., Los Angeles, Cal.
Donaldson, C. E., Actg. G. F. B. & B., C. Vt. R. R., St. Albans, Vt.
Douglas, L. H., Mast. Carp., B. & O. R. R., Cleveland, O.
Drake, R. M., M. of W. Asst., Sou. Pac. Co., San Francisco, Cal.
Draper, F. O., Supt. of Bridges, I. C. R. R., Chicago.
Draper, I. A., Steel Erec. For., O. S. L. R. R., Pocatello, Idaho.
Drum, H. R., Chief Carp., C. M. & St. P. Ry., Mitchell, S. D.
Duckett, W. E., Asst. Engr., C. M. & St. P. Ry., Minneapolis, Minn.
Dufort, S. E., Supv. B. & B., B. & M. R. R., Concord, N. H.
Dupree, James, For. W. S., C. T. H. & S. E. Ry., Crete, Ill.
Durfee, T. H., For. B. and B., C. & N. W. Ry., Huron, S. D.

Easton, G. A., Gen. Scale Insp., Sou. Pac. Co., West Oakland, Cal.
Edwards, W. R., Sr. Struct. Engr., I. C. C., Washington, D. C.
Eggers, C. H., Mast. Carp., C. R. I. & P. Ry., Little Rock, Ark.
Eggleston, H. H., Supvr. B. & B., C. G. W. R. R., Des Moines, Ia.
Eggleston, W. O., Insp. of Bridges, Erie R. R., Huntington, Ind.
Elder, W. E., Mast. Carp., C. B. & Q. R. R., Burlington, Iowa.
Elliott, R. O., Supvr. B. and B., L. & N. R. R., Nashville, Tenn.
Elwell, H. A., Supvr. B. & B., C. G. W. Ry., Clarion, Ia.
Esping, Chas., Mast. Carp., B. & O. C. T. R. R., Chicago
Estes, C. F., For. Brdgs., Pac. Elec. Ry., Los Angeles, Cal.
Ettinger, C., Gen. Ptr. For., I. C. R. R., Chicago.
Eubanks, J. E., Br. For., S. A. L. Ry., Yulee, Fla.
Evans, J. J., Supvr. Signals, P. M. R. R., Saginaw, Mich.

Fair, E. W., Supvr. B. & B., B. R. & P. Ry., Du Bois, Pa.
Fake, C. H., Engr. M. of W., M. R. & B. T. Ry., Bonne Terre, Mo.
Farlow, R. F., Mast. Carp., B. & O. S. W. R. R., Chillicothe, O.
Faulkner, L. E., Ch. Engr., Miss. Cent. R. R., Hattiesburg, Miss.
Fellows, C. W., For. W. S., C. & S. Ry., Denver, Colo.
Fenwick, G. H., Gen. Br. For., M. C. R. R., St. Thomas, Ont.
Ferdina, A. H., For. B. & B., St. L. I. M. & S. Ry., St. Louis.
Ferris, B. F., For. B. and B., Sou. Pac. Co., **Los Angeles.**
Findley, A., 929 Wash. Ave., Portland, Me.
Fink, Albert, Gen. For. B. &. B., D. L. & W. R. R., **Buffalo,** N. Y.
Finley, W. H., Ch. Engr., C. & N. W. Ry., Chicago.
Fisher, J. F., Bridge Inspr., Sou. Pac. Co., Sacramento, Cal.
Fisher, Morris, Supvr. B. & B., Sou. Pac. Co., **Ogden, Utah.**
Fisk, C. H., Ch. Engr. Const., St. Louis, 5142 Westminster Pl., St. Louis.
Fitzgerald, J. M., Roadmaster, C. of G. Ry., Macon, Ga.
Fletcher, J. W., Roadway Supt., Car. & N. W. Ry., Chester, S. C.
Fletcher, W. H., 108 7th Ave., Nashville, Tenn.
Flint, C. F., For. B. and B., C. V. R. R., **St. Albans, Vt.**
Flynn, M. J., For. B. and B., C. & N. W. Ry., Chicago.
Forsgren, Oscar, Brigham, Utah.
Fraser, Alex., Supvr. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Fraser, James, Ch. Engr., N. S. W. Govt. Rys., Sydney, N. S. W.
Fraser, Neil, Supv. B. & B., Sou. Pac. Co., Dunsmuir, Cal.
Frazier, W. C., Supvr. B. and B., L. A. & S. L. Ry., Los Angeles.
Froese, Julius, Gen. For. B. & B., A. T. & S. F. Ry., LaJunta, Colo.
Fullerton, J. H., Supv. B. & B., B. & M. R. R., Woodsville, N. H.

Gable, Franklin, For. Carp., P. & R. Ry., Catawissa, Pa.
Gaby, F. A., Ch. Engr. P. C. of Ont., Toronto, Ont.
Gagnon, Ed., Supvr. B. and B., M. & St. L. R. R., Minneapolis, Minn.
Galloway, W. J., Mast. Carp., S. A. L. R. R., Hamlet, N. C.
Gardner, E. F., Mast. Carp., Erie R. R., Buffalo, N. Y.
Garner, R. D., Engr. Const., S. N. E. Ry., Providence, R. I.
Gaunt, Fred, Ptr. For., O. S. L. R. R., Pocatello, Idaho.
Gaut, J. B., Supt. B. & B., G. T. Ry., Chicago.
***Gauthier, A. I.,** Supvr. B. & B., B. & M. R. R., Concord, N. H.
Gehr, B. F., Mast. Carp., P. C. C. & St. L. Ry., Richmond, Ind.
Gentis, Ira, B. and B. Foreman, Sou. Pac. Co., Oakland, Cal.
George, W. J., Bay Road, Claremont, W. Australia.
Gerst, H. A., Asst. Engr., Bridge Dept., G. N. Ry., St. Paul, Minn.
***Gilman, A. F.,** 1310 Hinman Ave., Evanston, Ill.
Giusto, Peter, For. B. & B., Sou. Pac. Co., San Francisco.
***Given, J. A.,** Asst. Div. Engr., Sou. Pac. Co., Sacramento, Cal.
Glasgow, J. F., Gen For B & B, C St P M & O Ry, Worthington, Minn.
Gnadt, C., Br. For., St. L. I. M. & S. Ry., Poplar Bluff, Mo.
Goldmark, Henry, Cons. Engr., 103 Park Ave., New York City.
Goldsmith, E. L., Supt. Const., L. I. R. R., Jamaica, N. Y.
Gooch, C. W., 1325 W. 9th St., Des Moines, Ia.
Gongoll, O. C., Asst. Supt. B. & B., Soo Line, Minneapolis, Minn.
Gradt, Chas. Ch. Carp., C. M. & St. P. Ry., Savanna, Ill.
Graham, F. N., Asst. Engr., D. M. & N. Ry., Duluth, Minn.
Graham, Wm., C. E., 3027 Windsor Ave., Baltimore, Md.
Gratto, James, Supvr. B. & B., S. P. Co., Los Angeles, Cal.
Graves, Lon, For. B. & B., St. L. I. M. & S. Ry., Dermott, Ark.
Green, C. F., Supvr. B. and B., Sou. Pac. Co., Sacramento, Cal.
Green, E. H. R., Pres., Texas Midland R. R., Terrell, Tex.
Green, Z. A., Pilot, Fed. Val., G. C. & S. F. Ry., Galveston, Tex.
Greiner, J. E., Civil Engineer, 605 Continental Bldg., Baltimore, Md.
Griffith, F. M., Supvr. B. and B., C. & O. Ry., Covington, Ky.
Grover, J. H., Gen. For. W. S., A. T. & S. F. Ry., Needles, Cal.
Guild, Edward, Supv. B. & B., P. M. R. R., Grand Ledge, Mich.

Guire, W. A., For. B. & B., St. L. I. M. & S. Ry., Lake Providence, La
***Guppy, B. W.,** Engr. Structures, B. & M. R. R., Boston, Mass.
Guretzky, J., Supvr. B. &. B., Col. Mid. Ry., Colorado City, Colo.

Hadwen, L. D., Engr. Masy. Const., C. M. & St. P. Ry., Chicago, Ill.
Haley, W. S., Res. Engr., N. Y. C. R. R., Toledo, O.
Hall, N. L., Supvr. B. & B., Sou. Ry., Greensboro, N. C.
Hall, Thomas, Asst. Supt. Bldgs., M. C. R. R., Jackson, Mich.
Hampton, H. A., Asst. Div. Engr., Sou. Pac. Co., Portland, Oregon.
***Hancock, John,** Engr. B. & B., U. Trac. Co. of Ind., Anderson, Ind.
Hand, Geo. W., Valuation Engr., C. & N. W. Ry., Chicago.
Hanks, G. E., 814 No. Wash. Ave., Saginaw, Mich.
Hansen, Robt., Carp. For., Sou. Pac. Co., West Oakland, Cal.
Hansen, Rupert, 517 Redondo Ave., Salt Lake City, Utah.
Hargrove, J. C., For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Harlow, A. W., Mast. Carp., Erie R. R., Huntington, Ind.
Harman, H. H., Engr. of Brs., B. & L. E. R. R., Greenville, Pa.
Harman, Wm. C., Br. Inspr., Sou. Pac. Co., Bakersfield, Cal.
Harris, C. J., For. B. and B., O. S. L. R. R., Roberts, Idaho.
Harris, W. B., Supv. of Track, M. & O. R. R., Corinth, Miss.
Harrison, Chas., Gen. For. B. & B., M. O. & G. Ry., Muskogee, Okla.
Harshbarger, C. A., Asst. Br. For., O. S. L. Ry., Ontario, Ore.
Hartley, James, Supvr. B. and B., N. P. Ry., Staples, Minn.
Harvey, E. H., St. L. I. M. & S. Ry., Montrose, Ark.
Hausgen, W., Supvr. B. and B., M. P. Ry., Sedalia, Mo.
Hawk, A. T., Archt., C. R. I. & P. Ry., Chicago.
Hawkins, E. P., Genl. R. M., St. L. I. M. & S. Ry., McGehee, Ark.
Hayes, J. L., Div. Engr., C. R. I. & P. Ry., Rock Island, Ill.
Heiszenbuttel, H., Genl. For. B & B., C. &. N. W. Ry., Norfolk, Neb.
Henderson, J., Foreman B. and B., G. T. Ry., St. Thomas, Ont.
Henderson, R. C., Mast. Carp., C. H. & D. Ry., Dayton, O.
Herrig, C., For. W. S., C. & N. W. Ry., Wall Lake, Iowa.
Hicks, Wm. G., M. of W. Dept., L. I. R. R., Jamaica, N. Y.
Higgins, H. K., Cons. Engr., 209 McBride St., Jackson, Mich.
Hill, H. R., Asst. Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
Hinchee, J. M., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
Hitesman, U. S., Gen. For., N. Y. C. R. R., New York City.
Hodges, F. J., C. C., M. C. R. R., Jackson, Mich.
Hodges, H. P., Asst. Engr. W. S., N. C. & St. L. Ry., Nashville, Tenn.
Hofecker, Peter, Supvr. B. and B., L. V. R. R., Auburn, N. Y.
Hoffman, Geo. M., For. Ptr., P. & R. Ry., Shamokin, Pa.
Holcomb, J. W., Supvr. B. & B., L. V. R. R., Buffalo, N. Y.
Holdridge, H. D., Supvr. B. and B., Y. & M. V. R. R., Vicksburg, Miss.
Hopke, W. T., Mast. Carp., B. & O. R. R., Grafton, W. Va.
Horning, H. A., Supt. of Bldgs., M. C. R. R., Jackson, Mich.
Horth, A. J., Mast. Carp., Erie R. R., Meadville, Pa.
Hotson, Wm. B., Supt. B. & B., E. J. & E. Ry., Joliet, Ill.
Howson, E. T., Eng. Editor, Railway Age Gazette, Chicago, Ill.
Hubbard, A. B., 32 Banks St., West Somerville, Mass.
Hudson, B. M., Supt. T. & B. V. Ry., Teague, Tex.
Hull, K. S., Supt., G. C. & S. F. Ry., Temple, Tex.
Humbert, A. T., Mast. Carp., B. & O. R. R., New Castle Jct., Pa.
Hume, E. S., Deputy Com'r., W. A. Govt. Rys., Perth, W. Australia.
Hunciker, John, For. Bridge Erection, C. & N. W. Ry., Chicago.
Huntoon, J. S., Supv. Bridges, M. C. R. R., Detroit, Mich.
Hurst, Walter, Inspector, C. B. & Q. Ry., Chicago, Ill.
Hutchens, J. A., Bridge Insp., Sou. Pac. Co., Ogden, Utah.

Ingalls, F., Supvr. B. and B., N. P. Ry., Jamestown, N. D.
Ingram, Floyd, Supvr. B. and B., L. & N. R. R., Erin, Tenn.
Innes, J., Gen. For., G. T. Ry., Hamilton, Ont.

Irving, T. J., Asst. Engr., C. & N. W. Ry., Boone, Iowa.
Irwin, J. W., Genl. For. B. & B., C. & N. W. Ry., Chadron, Neb.
Isaacs, Jno. D., Consulting Engr., Sou. Pac. Co., New York City.

Jack, H. M., Gen'l For. B. and B., I. & G. N. R. R., Palestine, Tex.
Jackson, E. A., For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Jackson, W. J., Div. Engr., C. & N. W. Ry., Winona, Minn.
James, A. J., Gen. For. B. & B., A. T. & S. F. Ry., Topeka, Kans.
James, Harry, Gen'l For. B. and B., C. & S. Ry., Denver, Col.
James, R. E., Supv. B. & B., L. V. R. R., Sayre, Pa.
Jennings, Geo. H., Asst. Ch. Engr., E. J. & E. Ry., Joliet, Ill.
Jensen, C. A., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
Jewell, J. O., Supt. B. and B., C. T. H. & S. E. Ry., Terre Haute, Ind
Johnson, C. H., For. B. & B., P. M. R. R., Reese, Mich.
Johnson, Maro, Asst. Engr., I. C. R. R., Chicago.
Johnson, Nels, Supv. B. & B., C. G. W. R. R., St. Charles, Ill.
Johnson, Phelps, Pres. St. Lawrence Bridge Co., Montreal, Que.
Johnston, C. E., Genl. Mgr., K. C. Sou. Ry., Kansas City, Mo.
Johnston, J. H., Supt. B. & B., G. T. Ry., Montreal, Que.
***Jonah, F. G.**, Chief Engr., St. L. & S. F. R. R., St. Louis, Mo.
Jonas, H. F., Engr. Struct., S. P. Lines, Tex. & La., Houston, Tex
Jones, L. E., Asst. Engr., N. O. & N. E. R. R., New Orleans, La.
Jones Pusey, Act. Engr. Strs., B & M. R. R., Boston, Mass.
Joslin, Judson, Genl. For. B. & B., L. V. R. R., Auburn, N. Y.
Jutton, Lee, Div. Engr., C. & N. W. Ry., Chicago, Ill.

Keefe, D. A., Consulting Engr., Athens, Pa.
Keith, H. C., Civil Engineer, 154 Nassau St., New York City.
Kelly, C. W., Peoples Gas Building, Chicago.
Kelly, J. A., Asst. Supv. B. & B., O. S. L. R. R., Pocatello, Idaho.
Kemp, A. E., For. B. & B., L. V. R. R., Hazleton, Pa.
***Kibbey, G. S.**, Asst. Engr., M. & St. L. R. R., Minneapolis, Minn.
Killam, A. E., 84 Highfield St., Moncton, N. B.
King, A. H., Supvr. B. and B., O. S. L. R. R., Pocatello, Idaho.
King, C. F., Div. Engr., C. & N. W. Ry., Omaha, Neb.
King, F. E., Dist. Carp., C. M. & St. P. Ry., Minneapolis, Minn.
King, T. H., Supv. B. & B., L. & N. R. R., Knoxville, Tenn.
Kinzie, H. H., Supvr. B. and B., N. Y. N. H. & H. R. R., Taunton, Mass
Klumpp, G. J., Supvr. Bridges, N. Y. C. R. R., Rochester, N. Y.
Knapp, F. A., Mast. Carp., Erie R. R., Jersey City, N. J.
Knapp, G. A., Office Engr., G. C. & S. F. Ry., Galveston, Tex.
Knowles, C. R., Supt. Water Service, I. C. R. R., Chicago.
Krausch, W. T., Engr. Bldgs., C. B. & Q. R. R., Chicago, Ill.
Kulp, B. R., Trainmaster, C. & N. W. Ry., Antigo, Wis.
Kurokochi, S., Engineer, Imperial Govt. Rys., Tokyo, Japan.

Lacy, J. D., Insp., S. A. & A. P. Ry., 2517 Saltus St., Houston, Tex.
Lacy, W. J., For. B. & B., St. L. I. M. & S. Ry., Poplar Bluff, Mo.
La Fountain, N. H., Asst. Supt. of B. and B., C. M. & St. P. Ry., Chicago
Lamb, C. W., For. B. & B., St. L. I. M. & S. Ry., Pine Bluff, Ark.
Land, G. W., Supvr. B. and B., St. L. I. M. & S. Ry., McGehee, Ark.
Lanning, W. R., Ch. Carp., C. M. & St. P. Ry., St. Maries, Idaho.
Large, H. M., Mast. Carp., G. R. & I. Ry., Fort Wayne, Ind.
Larsen, A., Asst. Engr., C. Vt. Ry., St. Albans, Vt.
Larson, John, Room 740, Transportation Bldg., Chicago.
Lattin, W. V., Supv. B. & B., N. Y. N. H. & H. R. R., Hartford, Conn
Lawrence, P. P., Asst. Supvr. B. & B., L. E. & W. R. R., Tipton, Ind.
Layfield, E. N., C. E., 61 Broadway, N. Y.
Leach, W. A., 150 Essex St., Holyoke, Mass.
Leake, T. S., Contractor, 6433 Kenwood Ave., Chicago.

Leavitt, F. J., Div. For. B. and B., B. & M. R. R., Sanbornville, N. H.
Lee, Frank, Prin. Asst. Engr., C. P. R., Winnipeg, Manitoba.
Lemond, J. S., Asst. to Ch. Engr. M. of W. & S., Sou. Ry., Charlotte, N. C.
Lentz, C. W., Genl. Bridge Insp., I. C. R. R., Memphis, Tenn.
Leonard, H. R., Engr. B. and B., P. R. R., Philadelphia, Pa.
Leslie, Andrew, Div. For., M. C. R. R., St. Thomas, Ont.
Lewis, E. R., Asst. to G. M., D. S. S. & A. Ry., Duluth, Minn.
Lichty, C. A., Gen'l Insp., C. & N. W. Ry., Chicago.
Little, J. W., Asst. Supvr., B. & B., L. & N. R. R., Birmingham, Ala.
Littlefield, E. C., Ch. Clk., N. Y. N. H. & H. R. R., New Haven, Conn.
Lloyd, F. F., C. E., Petaluma, Cal.
Lodge, Harry, For. B. & B., Sou. Pac. Co., (care of G. W. Rear).
Loeffler, M., Supv. Brs., L. I. R. R., Jamaica, N. Y.
Loftin, E. L., Supvr. B. and B., Q. & C. Ry., Vicksburg, Miss.
Long, M. A., Asst. to Ch. Engr., B. & O. R. R., Baltimore, Md.
Lorch, J. A., Asst. Engr., C. & N. W. Ry., Chicago.
Loughery, E., Gen'l For. B. & B., T. & P. Ry., Dallas, Tex.
Loughnane, George, Div. Engr., C. & N. W. Ry., Escanaba, Mich.
Loweth, C. F., Ch. Engr., C. M. & St. P. Ry., Chicago.
*Lutken, P. K., Gen. For. B. & B., N. O. M. & C. R. R., Laurel, Miss.
Lydston, W. A., 105 Norfolk Ave., Swampscott, Mass.
Lyman, C. R., For. Brgs., C. Vt. Ry., Waterbury, Vt.

Mace, B. S., Supt. of Insurance, B. & O. R. R., Baltimore, Md.
Mackenzie, W. B., Civil Engineer, Moncton, N. B.
Macy, E. C., Supt. Const., Stone & Webster Eng. Corpn., 868 Stuart Bldg., Seattle, Wash.
Mahan, Wm., Mast. Carp., W. & L. E. R. R., Canton, Ohio.
Malloy, J. B., For. B. & B., Sou. Pac. Co., San Francisco.
Manley, B. F., Gen. For. B. & B., Pac. Elec. Ry., Los Angeles, Cal.
Mann, J. M., Gen'l For. B. and B., Ft. W. & D. C. Ry., Ft. Worth, Tex.
Manson, E. F., Mast. Carp., C. R. I. & P. Ry., Manly, Iowa.
Manthey, G. A., Asst. Supt. B. & B., Soo Line, Minneapolis, Minn.
Marcy, C. A., For. B. and B., C. & N. W. Ry., Chicago.
Markley, A. S., Mast. Carp., C. & E. I. R. R., Danville, Ill.
Markley, J. H., Mast. B. and B., T. P. & W. Ry., Peoria, Ill.
Marsh, John, For. B. and B., B. & M. R. R., Lawrence, Mass.
Marsh, M. M., Supt. W. & B., Northern Ry., Squirres, Costa Rica, C. A.
Maruyama, Y., C. E., Sou. Manchuria Ry., Dairen, Japan.
Massenburg, W. G., Engr. Gulf Lines, G. C. & S. F. Ry., Galveston, Tex.
Mathews, J. D., Div. Engr., Sou. Pac. Co., Tucson, Ariz.
Mattos, F. D., Supt. Pres. Wks., S. P. Co., W. Oakland, Cal.
May, A. D., Asst. Engr., Mo. Pac. Ry., Little Rock, Ark.
McCabe, E. M., Supv. B. & B., B. & A. R. R., Pittsfield, Mass.
McCallum, A. D., For. W. S., C. H. & D. Ry., Hamilton, O.
McCandless, C. W., For. B. & B., Sou. Pac. Co., Ventura, Cal
McCann, E., Gen. For. B. and B., A. T. & S. F. Ry., Wellington, Kans.
McCaulley, S. W., C. E., 1428 E. 68th St., Chicago, Ill.
McClanahan, S. L., Div. Engr., C. R. I. & P. Ry., Herington, Kans.
McCloy, A. L., For. B. & B., P. M. R. R., Reese, Mich.
McClure, J. C. E., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
McCormick, R. S., Ch. Engr., A. C. & H. B. R., Sault Ste. Marie, Ont.
McCue, G. C., Gen. Supvr. B. & B., G. T. Ry., Ottawa, Ont.
McCully, C. S., Gen'l For. B. and B., N. P. Ry., Jamestown, N. D.
McDearmid, W. A., Mast. Carp., S. A. L. Ry., Charleston, S. C.
McDonald, Hunter, Ch. Engr., N. C. & St. L. Ry., Nashville, Tenn.
McFadden, T. E., Chief Carp., C. M. & St. P. Ry., Cedar Falls, Wash.
McGee, Danl., For. B. & B., Sou. Pac. Co., Sacramento, Cal.
McGonagle, W. A., Pres., D. M. & N. Ry., Duluth, Minn.
McGuire, Edwd., Ch. Carp., C. M. & St. P. Ry., Marion, Iowa.

McIlhenny, O. R., Asst. Supv., N. O. & N. E. R. R., Laurel, Miss.
***McIntosh, Wm.,** Castle Stuart, Dalcross, Inverness-shire, Scotland.
McIver, B. T., Supvr. B. and B., D. & I. R. R. R., Two Harbors, Minn.
McKay, A. G., Div. For. Bldgs., N Y N H & H R R., New Haven, Conn.
McKee, D. L., Mast. Carp., P. & L. E. R. R., McKee's Rocks, Pa.
McKee, H. C., Insp. of Iron Bridges, C. of G. R. R., Macon, Ga.
McKeel, W. S., Mast. Carp., G. R. & I. Ry., Grand Rapids, Mich.
McKibben, Robert, Mast. Carp., P. R. R., Altoona, Pa.
McLean, Neil, Bridge Inspector, Erie R. R., Huntington, Ind.
McLeod, Angus M., For. B. & B., Sou. Pac. Co., Oakland, Cal.
McNab, A., Supvr. B. and B., P. M. R. R., Holland, Mich.
McNaughton, H. C., Div. For. B. & B., B. & M. R. R., Concord, N. H.
McRae, D. A., Carp. For., C. P. R., Lethbridge, Alberta.
McRostie, Roy, Asst. For. Const., O. S. L. R. R., Pocatello, Ida.
McVay, A. B., Supvr. B. and B., L. & N. R. R., Evansville, Ind.
Mellgren, J., For. W. S., C. & N. W. Ry., Eagle Grove, Iowa.
Meloy, E. S., Asst. Engr., C. M. & St. P. Ry., Chicago.
Mercier, A. T., Asst. Supt., Sou. Pac. Co., Dunsmuir, Cal.
Meyer, H. W., Struct. Engr., Fairmont, W. Va.
Meyers, W. F., For. B. and B., C. & N. W. Ry., Boone, Iowa.
Middleton, R. J., Val. Engr., C. M. & St. P. Ry., Chicago, Ill.
Miller, A. F., Mast. Carp., Penn. Lines W. of Pitts., Chicago.
Miller, C. E., Asst. Gen. Br. Insp., C. & N. W. Ry., Chicago.
Miller, J. W., Archt., C. & N. W. Ry., Chicago.
Miller, M. D., Spl. Engr., 740 Transportation Bldg., Chicago.
Mills, R. P., Supvr. Bldgs., N. Y. C. R. R., New York City.
Mines, Chas., Gen. For. B. & B., C. St. P. M. & O. Ry., Emerson, Neb
Mitchell, G. A., Supt. B. and B., G. T. Ry., Toronto, Ont.
Mitchell, L. A., Eng. M. & W., U. T. Co. of Ind.; Anderson, Ind.
Moen, J. D., Supt. B. & B., C. St. P. M. & O. Ry., St. Paul, Minn.
Montzheimer, A., Ch. Engr., E. J. & E. Ry., Joliet, Ill.
Moore, E. G., For. Carpenter, B. & O. R. R., Flatwoods, W. Va.
Moore, W. H., Eng. of Brgs., N. Y. N. H. & H. R. R., New Haven, Conn
Morgan, Homer, For. B. & B., P. M. R. R., Greenville, Mich.
Morrison, E. C., Div. Engr., Sou. Pac. Co., San Francisco.
Mountain, G. A., Ch. Engr., Ry. Com. of Canada, Ottawa, Ont.
Mountfort, Albert, Div. For. B. and B., B. & M. R. R., Nashua, N. H.
Mulcahy, W. H., For. B. & B., C. & N. W. Ry., Adams, Wis.
Munson, S. P., Chief Clerk, I. C. R. R., Mattoon, Ill.
Murphy, J. J., For. Water Service, Sou. Pac. Co., Oakland, Cal.
Murphy, R. E., For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Murray, J. R., Supvr. B. & B., A. G. S. R. R., Tuscaloosa, Ala.
Murray, Edwd., Asst. Engr. B. & B., C. M. & St. P. Ry., Miles City, Mont
Musgrave, C. T., For. B. & B., O. S. L. R. R., Idaho Falls, Idaho.
Musser, D. G., Mast. Carp., Penn. Lines W. of Pitts., Wellsville, Ohio

Nelson, J. C., Engr. M. of W., S. A. L. Ry., Norfolk, Va.
Nelson, M. E., Engr. Brdgs., A. C. L. R. R., Wilmington, N. C.
Nelson, O. T., Supt. M. of W., A. & W. P. R. R., Atlanta, Ga.
Nelson, P. N., Supv. B. & B., Sou. Pac. Co., San Francisco, Cal.
Newton, E. O., Div. For. Bldgs., N. Y. N. H. & H. R. R., Danbury, Conn.
Newton, R., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Nies, A. B., Archt., M. C. R. R., Jackson, Mich.
Noland, W. B., Supvr. B. & B., O. A. & E. Ry., Sacramento, Cal.
Noon, W. M., 617 Ave. G., Miami, Fla.
Nuelle, J. H., Genl. Supt., N. Y. O. & W. R. R., Middletown, N. Y.
Nuss, G. K., G. F. B. & B., D. M. & N. Ry., Proctor, Minn.

O'Connor, W. F., Supvr. Bridges, L. I. R. R., Flushing, N. Y.
Oldham, W. J., B. & B. Master, T. & N. O. Ry., North Bay, Ont.
Oliver, W. H., Div. Engr., A. T. & S. F. Ry., San Bernardino, Cal.
O'Neill, P. J., Mast. Carp., N. Y. C. R. R., Adrian, Mich.
Osborn, F. C., Cons. Engr., 2848 Prospect Ave., S. E., Cleveland, O.
Owen, John, For. B. & B., D. & M. Ry., East Tawas, Mich.

Page, A. A., Div. For. B. & B., B. & M. R. R., Wilmington, Mass.
Palmer, E. F., For. B. & B., B. & M. R. R., Salem, Mass.
Parker, J. F., Gen. For. B. & B., A. T. & S. F. Ry., San Bernardino, Cal
Parker, W. V., B. & B. Fr., St. L. S. W. Ry., Fordyce, Ark.
Parks, J., 3347 Boulevard F., Denver, Colo.
Parsons, P. E., Asst. Supv. B. & B., O. S. L. R. R., Pocatello, Idaho.
Paterson, E. E., Plumber For., O. S. L. R. R., Pocatello, Idaho.
Pauba, A. W., For. B. and B., C. & S. Ry., Denver, Colo.
Peabody, K., Asst. Supv. Bldgs., N. Y. C. R. R., New York City.
Penwell, J. N., Supt. Ogle Const, Co., Tipton, Ind.
Perkins, H. D., 1501 Walnut St., Danville, Ill.
Pettis, W. A., Gen. Supv. Bldgs., N. Y. C. R. R., Rochester, N. Y.
Phillips, B. P., Asst. Sup. B & B, N Y N H & H R R, Willimantic, Conn.
Pickering, B. F., Supvr. B. & B., B. & M. R. R., Salem, Mass.
***Pickering, F. M.**, Trainman, B. & M. R. R., Salem, Mass.
Pierce, Roy, Mast. Carp., Erie R. R., Salamanca, N. Y.
Pinson, J. F., Asst. Engr. B. & B., C. M. & St. P. Ry., Seattle, Wash.
Piper, E. B., Div. For. B. & B., B. & M. R. R., Fitchburg, Mass.
Pitcher, C. G., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Plank, D. E. Supvr. B. and B., Pac. Elec. Ry., Los Angeles, Cal.
Pollard, Harry, Asst. Gen'l Br. Insp., S. P. Co., San Francisco, Cal.
Pollard, Homer, Bridge Inspr., Sou. Pac. Co., West Oakland, Cal.
Pollock, H. H., Mast. Carp. of Bldgs., P. C. C. & St. L. Ry., Carnegie, Pa
Porter, L. H., Box 35, Andover, Conn.
Post, J. C., B. & B. For., L. A. & S. L. R. R., Los Angeles, Cal.
Potter, A. K., Inspector, C. & N. W. Ry., Antigo, Wis.
Potts, J. O., M. of W. Inspr., B. & O. R. R., Baltimore, Md.
Powell, C. E., Genl. Insp. Brgs., C. & O. Ry., Hinton, W. Va.
Powell, S. J., Div. For. B. & B., O. S. L. R. R., Ogden, Utah.
Powers, G. F., Contractor (Newkirk & Powers), Joliet, Ill.

Quinn, William, Supt. B. & B., St. L. S. W. Ry., of T., Tyler, Tex.

Rankin, W. F., Mast. Carp., Pa. Lines West, Cambridge, Ohio.
Rask, A. G., Supvr. B. & B., C. St. P. M. & O. Ry., Altoona, Wis.
Ratliff, W. L., Supvr. B. & B., I. C. R. R., McComb, Miss.
Ray, G. T., Supv. B. & B., St. J. & G. I. R. R., Marysville, Kans.
Rear, G. W., Gen'l Insp., S. P. Co., San Francisco, Cal.
Redfield, J. A. S., Div. Engr., C. & N. W. Ry., Fond du Lac, Wis.
Redinger, C. A., Res. Engr., Sou. Ry., Selma, N. C.
Reid, R. H., Supvr. Bridges, N. Y. C. R. R., Cleveland, Ohio.
Replogle, J. S., For. B. & B., Sou. Pac. Co., Oakland, Cal.
Rettinghouse, H., Ch. Engr., C. St. P. M. & O. Ry., St. Paul, Minn.
Reynolds, A. W., Mast. Carp., P. R. R., Jersey City, N. J.
Reynolds, J. V., For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Rice, A. P., Roadmaster, C. N. & L. R. R., Columbia, S. C.
Rich, B. D., Painter For., Sou. Pac. Co., Stockton, Cal.
Richards, G. T., Supt. B. & B. Shops, C. M. & St. P. Ry., Tomah, Wis.
Richardson, R. W., Div. Engr., C. & N. W. Ry., Sioux City, Ia.
Ridgway, Arthur, Asst. Ch. Engr., D. & R. G. R. R., Denver, Colo.
Riney, M., Gen'l For. B. and B., C. & N. W. Ry., Baraboo, Wis.
***Rintoul, D. T.**, Gen'l For. B. and B., Sou. Pac. Co., Bakersfield, Cal.
Robertson, A. A., Supr. B. and B., N. W. Pac. Ry., San Rafael, Cal.

Robinson, A. W., Div. Engr., O. S. L. R. R., Pocatello, Idaho.
Robinson, J. S., Div. Engr., C. & N. W. Ry., Chicago.
Robinson, John, Supvr. B. and B., P. M. R. R., Grand Rapids, Mich.
Robinson, R. B., Engr. M. of W., O. S. L. R. R., Pocatello, Idaho.
Rodman, G. A., Supt. B. & B., N. Y. N. H. & H. R. R., New Haven, Conn.
Rogers, W. A., Civil Engineer, 37 W. Van Buren St., Chicago.
Rohbock, W. L., Ch. Engr., W. & L. E. R. R., Cleveland. Ohio.
Rohr, E. J., Asst. Br. Supv., C. & O. Ry., Brighton Sta., Cincinnati, O.
Roper, D. L., For. B. & B., St. L. I. M. & S. Ry., Monroe, La.
Rose, Norman, Supvr. B. and B., Sou. Pac. Co., Portland, Ore.
Rose, W. M., For. Water Service, Sou. Pac. Co., Sacramento. Cal.
Ross, William, Chief Carp., C. M. & St. P. Ry., Millbank, S. D.
Rcunseville, D., Eng. Maint., C. & N. W. Ry., Chicago.
Roy, C. M., Gen. Bridge For., L. & N. R. R., Birmingham, Ala.
Ruge, Aug., Supvr. B. & B., C. St. P. M. & O. Ry., Mankato, Minn.
Runyon, C. C., For. B. & B., St. L. I. M. & S. Ry., Gorham, Ill.
Rykenboer, E. J., Supvr. Bldgs., N. Y. C. R. R., Rochester, N. Y.

Sampson, G. T., Asst. Engr., N. Y. N. H. & H. R. R., Boston.
Sattley, R. C., Valuation Engr., C. R. I. & P. Ry., Chicago.
Schall, F. E., Bridge Engr., L. V. R. R., So. Bethlehem, Pa.
Scheetz, F. B., Dept. Valuation, I. C. C., Kansas City. Mo.
Schoolcraft, C. S., For. Brgs., C. Vt. R., Farnham, Que.
Schuessler, W. B., Supvr. B. & B., N Y N H & H R. R., Waterbury, Conn
Scott, Chas., Supvr. B. & B., B. R. & P. Ry., E. Salamanca, N. Y.
Scribner, C. J., Bldg. Inspr., C. B. & Q. Ry., Chicago.
Searls, Niles, Gen. Fire Inspector, Sou. Pac. Co., San Francisco, Cal.
Secord, Fred, For. B. & B., Sou. Pac. Co., Sacramento, Cal.
Sedmoradsky, C., For. B. & B., C. St. P. M. & O. Ry., Worthington, Minn.
Sedwell, G. W., Tunnel For., Sou. Pac. Co., Bakersfield. Cal.
Seeley, L. T., Gen. For. B. & B., A. T. & S. F. Ry., Needles, Cal.
Seely, S. A., Asst. Engr., N. Y. C. R. R., Utica, N. Y.
Self, E. P., Supv. Bldgs., L. I. R. R., Jamaica, N. Y.
Sellew, W. H., Valuation Dept., M. C. R. R., Detroit, Mich.
Settle, T. H., Gen. For. B. & B., S. P. Co., Los Angeles, Cal.
Shane, A., Box 71, Indianapolis, Ind.
Shanklin, F. E., Gen. For.. C. & N. W. Ry., Belle Plaine, Iowa.
Sharp, J. S., Res. Engr., N. O. & N. E. R. R., New Orleans, La.
Sharpe, D. W., Supv. B. & B., N. Y. N. H. & H. R. R., New Haven, Conn
Sharpe, T. E., Supvr. B. and B., Sou. Ry., Greenville. S. C.
Shean, J. R., Ptr. For., Pac. Elec. Ry., Los Angeles. Cal.
Sheldon, J. B., Supvr. B. & B., N. Y. N. H. & H. R. R., Providence, R. I.
Sheley, Wm., Asst. Supvr. B. and B., L. & N. R. R., Evansville, Ind.
Shields, A. C., Div. Engr., C. R. I. & P. Ry., Trenton. Mo.
Shifflet, Parker, For. Br. Erec., O. S. L. R. R., Pocatello, Idaho.
Shope, D. A., Fresno, Cal.
Shropshire, W., Supvr. of B. and B., Y. & M. V. R. R., Greenville. Miss
Sibley, C. A., Engr. & Contr., 902 Chapel St., New Haven. Conn.
Siefer, F. M., Div. Engr., Sou. Pac. Co., Sacramento, Cal.
Simmons, I. L., Br. Engr., C. R. I. & P. Ry., Chicago.
Sinclair, E. L., Asst. Engr., C. M. & St. P. Ry., Marion, Iowa.
Sisson, F. P., Asst. Engr., G. T. Ry., Detroit, Mich.
Skeoch, Jas., Gen. For. B. & B., D. L. & W. R. R., Dunmore. Pa.
Slabotsky, H., Asst. Engr., M. L. & T. R. R. & S. S. Co., Lafayette, La
Smetters, S. T., Asst. Br. Engr., Sanitary Dist. of Chicago, Chicago. Ill.
Smith, A. W., Bridge Dept. C. N. Ry., Winnipeg, Manitoba.
Smith, C. E., Consulting Engr., 2075 Ry. Exch. Bldg., St. Louis Mo.
Smith, C. U., Asst. Engr., C. M. & St. P. Ry., Milwaukee. Wis.
Smith, C. W., Asst. Supvr. B. & B., Sou. Pac. Co., Portland. Ore
Smith, E. U., Ch. Dft., The Austin Co., 1026 Bulletin Bldg., Philada., Pa.
Smith, E. W., Architect Val., M. C. R. R., Detroit, Mich.

Smith, L. D., C. E., Room 18, Ferry Bldg., San Francisco.
Smith, M. A., Gen. For. B. & B., I. C. R. R., New Orleans, La.
Smith, R. W., Gen. For. B. & B., T. & B. V. Ry., Teague, Tex.
Smith, Wm., For. W. S., St. L. I. M. & S. Ry., McGehee, Ark.
Snow, J. P., 1120 Kimball Bldg., Boston, Mass.
Snyder, A. M., Supv. B. & B., L. & N. E. R. R., Pen Argyl, Pa.
Soisson, J. L., Gen'l For. B. and B., N. Y. C. R. R., Norwalk, Ohio.
Sorensen, Wm., For. B. & B., O. S. L. R. R., Brigham, Utah.
Sorrells, O. M., Asst. Div. Engr., N. C. & St. L. Ry., Atlanta, Ga.
Spalding, Lawrence, Supv. Struct., B. & L. E. R. R., Greenville, Pa.
Spell, W. A., Ch. Draftsman, A. B. & A. Ry., Atlanta, Ga.
Spencer, Jos., For. B. & B., G. T. Ry., Stratford, Ont.
Spencer, Wm., C. & N. W. Ry., Norfolk, Neb.
Stamler, H., Supvr. B. & B., L. & N. R. R., Paris, Ky.
Stannard, James, 1602 Broadway, Kansas City, Mo.
Staten, J. M., Gen'l Bridge Insp., C. & O. Ry., Richmond, Va.
Steadham, J. J., Supv. B. & B., N. O. & N. E. R. R., New Orleans, La.
Steffens, W. F., Special Engr., N. Y. C. Lines, New York City.
Sterling, W. M., Ch. Clerk, C. & N. W. Ry., Chicago.
Stern, I. F., C. E., Old Colony Bldg., Chicago.
Stevens, A. R., For. B. and B., O. S. L. R. R., Pocatello, Idaho.
Stewart, G. H., Master Mason, B. R. & P. Ry., Salamanca, N. Y.
Stewart, John, Gen. For. B. & B., C. St. P. M. & O. Ry., Spooner, Wis.
Stewart, W A., For. Brgs., C. Vt. R. R., New London, Conn.
Stewart, W. G., Supvr. B. and B., L. & N. R. R., Nashville, Tenn.
Stiver, C. C., Scale Insp., B. & O. R. R., Garrett, Ind.
Stone, L. W., Supvr. B. & B., N. Y. C. R. R., Oswego, N. Y.
Storck, E. G., Mast. Carp., P. & R. Ry., Philadelphia, Pa.
Strothers, R. R., Asst. Engr., C. & St. P. M. & O. Ry., St. Paul, Minn.
Strouse, W. F., Asst. Engr., B. & O. R. R., 400 Forest Road, Baltimore.
Stuart, H. B., Struct. Engr., G. T. Ry., Montreal, Que.
Stuart, T. J., Supvr. B. and B., W. Pac. Ry., Elko, Nev.
Sullivan, William, Care Div. Supt., Mo. Pac. Ry., Kansas City, Mo.
Suter, O. M., Supvr. B. & B., I. C. R. R., Chicago.
Swain, G. F., Prof. C. E., Harvard University, Cambridge, Mass.
Swan, L. W., Supvr. B. and B., L. V. R. R., Easton, Pa.
Swartz, A., Vice Pres., Toledo & Western R. R., Sylvania, Ohio.
Swartz, H. C., Master B & B., G. T. R., St. Thomas, Ont.
Swartz, W. G., Asst. Engr. Const., G. T. R., Campbellford, Ont.
Sweeney, Wm., For. B and B., C. & N. W. Ry., Green Bay, Wis.
Swenson, A. M, (C. F. Massey Co.,) Peoples Gas Bldg., Chicago, Ill.
Swenson, P., Supt. B. and B., M. St. P. & S. Ste. M. Ry., Minneapolis.
Sydell, A. C., Chief Draftsman, C. B. & Q. R. R., Chicago, Ill.

Talbott, J. L., Gen'l For. B. and B., A. T. & S. F. Ry., Pueblo, Col.
Tanner, F. W., Insp. M. of W., Mo. Pac. Ry., St. Louis, Mo.
Tanner, S. C., Mast. Carp., B. & O. R. R., Baltimore, Md.
Tattershall, E. R., Supvr. B. & B., N. Y. C. R. R., Malone, N. Y.
Taylor, D. B., Mast. Carp., B. & O. R. R., Garrett, Ind.
Taylor, F. A., Mast. Carp., B. & O. R. R., Cumberland, Md.
Taylor, Herbert, Supvr. B. and B., D. & R. G. R. R., Alamosa, Colo.
Taylor, J. J., Supt. B. & B., K. C. S. Ry., Texarkana, Tex.
Teaford, J. B., Supvr. B. & B., Sou. Ry., Louisville, Ky.
Templin, E. E., For. Carp., P. & R. Ry., Pottsville, Pa.
Tewksbury, D. G., Supvr. B. & B., St. L. I. M. & S. Ry., Gorham, Ill.
Thomas, M. E., Div. Engr., C. & N. W. Ry., Boone, Iowa.
Thomas, T. E., Mast. Carp., B. & O. R. R., Philadelphia, Pa.
Thompson, C., Supt. Newkirk & Powers Const. Co., Joliet, Ill.
Thompson, C. S., Supt. B. and B., D. & R. G. R. R., Denver.
Thompson, E. E., G. F. B. & B., A. E. R. R., Phœnix, Ariz.
Thompson, F. J., Asst. Supv. B. & B., F. E. C. Ry., St. Augustine, Fla.

Thompson, F. L., Asst. Ch. Engr., I. C. R. R., Chicago.
Thompson, H. C., Div. Engr., N. Y. C. R. R., Weehawken, N. J.
Thomson, J. L., Gen. Insp. B. & B., D. & R. G. R. R., Salt Lake City.
Thorn, J. O., C. B. & Q. R. R., Beardstown, Ill.
Thorn, S. B., Div. For. Bldgs., M. C. R. R., Bay City, Mich.
Tichbourne, W. H., Supvr. B. & B., G. T. Ry., London, Ont.
Todd, R. E., Asst. Engr., C. & N. W. Ry., Madison, Wis.
Toohey, J. E., Gen'l For. B. and B., P. M. R. R., Grand Rapids, Mich.
Trapnell, Wm., Supt. C. & C. Ry., Elkins, W. Va.
Tratman, E. E. R., Ed. Eng. News-Record, Old Colony Bldg., Chicago, Ill.
Travis, J. E., Pinehurst, Wash.
Tretheway, Thos., For. B. & B., Sou. Pac. Co., Stockton, Cal.
Turnbull, T. B., Supt. B. & B., A. A. R. R., Owosso, Mich.
Turner, W. F., Asst. Div. Engr., Sou. Pac. Co., Ogden, Utah.
Tyers, W. J., Supvr. B. & B., G. T. Ry., Belleville, Ont.

Ullery, O. E., Asst. Engr., C. & N. W. Ry., Sioux City, Ia.
Urbutt, C. F., Engr. Track Elev., C. M. & St. P. Ry., Chicago, Ill.

Vandercook, Wesley, Ch. Engr., S. A. & S. W. Ry. Sys., Lake Charles, La.
Vance, W. H., Engr. M. of W., St. L. S. W. Ry., Tyler, Tex.
Vatter, E. J., For. P. & W., B. & M. R. R., Salem, Mass.
Vincent, E. J., For. B. & B., Sou. Pac. Co., Los Angeles.
Vollmer, C. G., Ch. Carp., C. M. & St. P. Ry., Elk Point, So. Dak.
Von Schrenk, Hermann, Cons. Timber Engr., 4276 Fladd Ave., St. Louis.

Wackerle, L. J., Supvr. B. & B., Mo. Pac. Ry., Osawatomie, Kans.
Wagner, R., Pile Driver For., C. R. I. & P. Ry., Little Rock, Ark.
Waits, A. L., For. B. and B., St. L. I. M. & S. Ry., St. Louis, Mo.
Walker, I. O., Div. Engr., W. & A. R. R., Atlanta, Ga.
Wallenfelsz, J., Mast. Carp., Pa. Lines W., Cambridge, O.
Warcup, C. F., For. W. S., G. T. R., St. Thomas, Ont.
Watson, P. N., Supvr. B. and B., Maine Central R. R., Brunswick, Me
***Webb, Geo. H.**, Ch. Engr., M. C. R. R., Detroit, Mich.
Wehlen, Charles, Br. Inspr., L. I. R. R., Jamaica, N. Y.
Weir, C. F., Supvr. B. & B., P. M. R. R., St. Thomas, Ont.
Weise, F. E., Chief Clerk, Eng. Dept., C. M. & St. P. Ry., Chicago.
Weldon, A., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
Welker, G. W., Supvr. B. and B., Southern Ry., Alexandria, Va.
Wells, C. R., Br. For., Sou. Pac. Co., Sacramento, Cal.
Wells, D. T., Genl. For. B. & B., O. S. L. R. R., Salt Lake City, Utah.
Wells, L. N., Div. For., B. & M. R. R., Woodsville, N. H.
Wenner, E. R., Supvr. B. and B., L. V. R. R., Ashley, Pa.
Wheaton, L. H., Div. Engr., Intercolonial Ry., Dartmouth, N. S.
Wherren, F. M., Div. For. B. & B., B. & M. R. R., Salem, Mass.
White, F. W., Supvr. B. & B., L. V. R. R., Sayre, Pa.
White, J. B., For. W. S., C. & N. W. Ry., Boone, Ia.
Whitmee, G. Y., For. W. S., P. M. R. R., Grand Rapids, Mich.
Whitney, W. C., Sen. Archt., I. C. C., 1907-15th St. N. W., Wash., D. C.
Wicks, Warren, Gen'l For., L. I. R. R., Amityville, N. Y.
Wilkinson, J. M., Supvr. B. and B., C. N. R. R., Van Wert, Ohio.
Wilkinson, W. H., Bridge Insp., Erie R. R., Elmira, N. Y.
Williams, J. C., Supvr., Georgia R. R., Decatur, Ga.
Williams, M. R., Gen. For. B. & B., A. T. & S. F. Ry., Las Vegas, N. M.
Wilson, E. E., Supv. Brgs., N Y C R R, New York City (81 E. 125th St.)
Wilson, J., Supvr. B. & B., G. T. Ry., Hamilton, Ont.
Wilson, M. M. Div. Br. Inspr., Sou. Pac. Co., Los Angeles
Wilson, W. W., Div. Engr., G. C. & S. F. Ry., Galveston, Tex.
Winter, A. E., C. E., 257 Cathedral Pl., St. Paul, Minn.
Winter, J. L., Mast. Carp., S. A. L. Ry., Waldo, Fla.
Wise, E. F., 207 Clay St., Waterloo, Iowa.
Wishart, J. J., Supvr. B. & B., N. Y. N. H. & H. R. R., Boston, Mass.

Witt, C. C., **Dist. Engr., I. C. C., 1020 McGee St., Kansas City, Mo.**
Wolf, A. A., Dist. Carp., C. M. & St. P. Ry., Milwaukee, Wis.
Womeldorf, C. F., Asst. Engr., C. & N. W. Ry., Chicago, Ill.
Wood, J. P., Supvr. B. & B., P. M. R. R., Saginaw, Mich
Wood, J. W., Gen'l For. B. and B., A. T. & S. F. Ry., San Bernardino, Cal.
Wood, W. E., Dist. Engr., C. M. & St. P. Ry., Chicago.
Wright, C. W., Mast. Carp., L. I. R. R., Jamaica, N. Y.
Wright, G. A., Gen. For. B. & B., Ill. Trac. Sys., Decatur, Ill.

Yappen, Adolph, Dist. Carp., C. M. & St. P. Ry., Chicago.
Yates, J. P., Gen. For. B. & B., N. O. T. & M. R. R., DeQuincy, La.
Yereance, W. B., Cons. Engr., 128 Broadway, New York City.
Young, R. C., Chief Engr., L. S. & I. Ry., Marquette, Mich.

Zenor, D., For. B. & B., L. & A. Ry., Stamps, Ark.
Zinsmeister, E. C., Mast. Carp., B. & O. R. R., Newark, O.
Zook, D. C., Mast. Carp., Pa. Lines W. of Pitts., **Ft.** Wayne, **Ind.**
Zorn, J. F., For. B. & B., Pac. Elec. Ry., Los Angeles, Cal.

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LIFE MEMBERS

Austin, C. P., 107 Park St., Medford, Mass.
Bailey, S. D., Mich. Cent. R. R., Detroit, Mich.
Carmichael, Wm., St. J. & G. I. R. R., St. Joseph, Mo.
Carpenter, J. T., 345 No. Bartlett St., Medford, Ore.
Cummin, Jos. H., Bay Shore, N. Y.
Findley, A., 929 Wash. Ave., Portland, Me.
Gooch, C. W., 1325 W. 9th St., Des Moines, Ia.
Green, E. H. R., Texas Midland R. R., Terrell, Tex.
Hanks, G. E., E. Saginaw, Mich.
Hubbard, A. B., 32 Banks St., West Somerville, Mass.
Killam, A. E., Moncton, N. B.
Loughery, E., Gen. For. B. & B., T. & P. Ry., Dallas, Tex.
Lydston, W. A., Swampscott, Mass.
Mackenzie, W. B., C. E., Moncton, N. B.
McLean, Neil, Mast. Carp., Erie R. R., Huntington, Ind.
Mountain, G. A., Ch. Engr., Ry. Com. of Canada, Ottawa, Ont.
Noon, W. M., Miami, Fla.
Parks, Jas., U. P. R. R., Denver, Colo.
Porter, L. H., Box 35, Andover, Conn.
Ross, Wm., C. M. & St. P. Ry., Millbank, So. Dak.
Shane, A., Box 71, Indianapolis, Ind.
Snow, J. P., 1120 Kimball Bldg., Boston, Mass.
Stannard, Jas., 1602 Broadway, Kansas City, Mo.
Tanner, Frank, Mo. Pac. Ry., St. Louis, Mo.
Thorn, J. O., C. B. & Q. R. R., Beardstown, Ill.
Wise, E. F., 207 Clay St., Waterloo, Ia.

DECEASED MEMBERS

Aldrich, G.
Amos, A.,
Andrews, O. H.
Berg, Walter G.
Bishop, Geo. J.
Biss, C. H.
Blair, J. A.
Bowman, A. L.
Brady, James
Cahill, M. F.
Carr, Charles
Causey, T. A.
Clark, W. M.
Cleaveland, H. D.
Connolly, C. G.
Costolo, J. A.
Crane, Henry
DeMars, James
Dunlap, H.
Edinger, F. S.
Ewart, John
Fletcher, H. W.
Forbes, Jno.
Foreman, John
Fuller, C. E.
Gaskin, W.
Gilbert, J. D.
Gilchrist, E. M.
Graham, T. B.
Hall, H. M.
Harwig, W. E.
Heflin, R. L.
Henson, H. M.
Hinman, G. W.
Holmes, H. E.
Hubley, John
Humphreys, Thos.
Isadell, L. S.
Johnson, J. E.
Keen, Wm. H.
Lantry, J. F.
Large, C. M.
Larson, G.
Lovett, J. W.
Mallard, C. C.
Markley, Abel S.
McCormack, J. W.
McGehee, G. W.
McIlwain, J. T.
McIntyre, Jas.
McKee, R. J.
McMahon, J.
Mellor, W. T.
Millner, S. S.
Mitchell, J. B.
Mitchell, W. B.
Morgan, J. W
Morgan, T. H.
Morrill, H. P
Patterson, S. F.
Peck, R. M.
Perry, W. W.
Phillips, H. W.
Powell, W. T.
Reid, G. M.
Renton, Wm.
Reynolds, E. F.
Robertson, Daniel
Schaffer, J.
Schenck, W. S.
Schwartz, J. C.
Soles, G. H.
Spafford, L. K.
Spangler, J. A.
Spaulding, E. C.
Spencer, C. F.
Taylor, J. W.
Thompson, N. W
Tozzer, Wm. S.
Trautman, J. J.
Travis, O. J.
Vandegrift, C. W.
Van Der Hoek, J.
Vaughan, Jas.
Wallace, J. E.
Walden, W. D.
Welch, E. T.
Wells, J. M.
Wood, W. B.
Worden, C. G.

MEMBERSHIP AND MILEAGE OF RAILWAYS REPRESENTED.

Name of Road and Membership.	Members.	Mileage.
Alabama & Vicksburg Ry.,	1	313
(Vicksburg, Shreveport & Pac. Ry.)		
E. L. Loftin, Vicksburg, Miss.		
Algoma Central & Hudson Bay Ry.	1	332
R. S. McCormick, Sault Ste. Marie, Ont.		
Ann Arbor R. R.,	1	292
T. B. Turnbull, Owosso, Mich.		
Arizona Eastern R. R.	1	373
E. E. Thompson, Phœnix, Ariz.		
Atchison, Topeka & Santa Fé Ry.,	5	5,968
Julius Froese, La Junta, Colo.		
A. J. James, Topeka, Kans.		
E. McCann, Wellington, Kans.		
John L. Talbott, Pueblo, Colo.		
M. R. Williams, Las Vegas, N. M.		
Atchison, Topeka & Santa Fé Ry. (Coast Lines)	6	2,053
E. E. Ball, Fresno, Cal.		
J. H. Grover, Fresno, Cal.		
W. H. Oliver, San Bernardino, Cal.		
J. F. Parker, San Bernardino, Cal.		
L. T. Seeley, Needles, Cal.		
J. W. Wood, Fresno, Cal.		
Atlanta & West Point R. R. and W. Ry. of Ala.	1	225
O. T. Nelson, Atlanta, Ga.		
Atlanta, Birmingham & Atlantic Ry.,	1	638
W. A. Spell, Atlanta, Ga.		
Atlantic Coast Line R. R.	2	4,744
M. E. Nelson, Wilmington, N. C.		
J. W. Salisbury, Port Tampa, Fla.		
Baltimore & Ohio R. R. (System),	22	6,627
G. W. Andrews, Baltimore, Md.		
S. H. Blowers, Columbus, O.		
W. S. Bouton, Baltimore, Md.		
Z. T. Brantner, Martinsburg, W. Va.		
H. R. Bricker, Baltimore, Md.		
G. S. Crites, Cincinnati, O.		
Chas. Esping, Chicago, Ill.		
R. F. Farlow, Chillicothe, O		

Name of Road and Membership.	Members.	Mileage.
Baltimore & Ohio R. R. (System). Continued.		
W. T. Hopke, Grafton, W. Va.		
A. T. Humbert, New Castle Jct., Pa.		
L. H. Douglas, Cleveland, O.		
M. A. Long, Baltimore, Md.		
B. S. Mace, Baltimore, Md.		
E. G. Moore, Flatwoods, W. Va.		
J. O. Potts, Baltimore, Md.		
C. C. Stiver, Garrett, Ind.		
W. F. Strouse, Baltimore, Md.		
S. C. Tanner, Baltimore, Md.		
D. B. Taylor, Garrett, Ind.		
F. A. Taylor, Cumberland, Md.		
T. E. Thomas, Wilmington, Del.		
E. C. Zinsmeister, Newark, O.		
Bangor & Aroostook R. R.	2	628
W. E. Alexander, Houlton, Me.		
M. Burpee, Houlton, Me.		
Bessemer & Lake Erie R. R.,	2	210
H. H. Harman, Greenville, Pa.		
L. Spalding, Greenville, Pa.		
Boston & Maine R. R.,	24	2,302
E. M. McCabe, Pittsfield, Mass.		
Boston & Maine R. R.,	23	2,302
Cyrus P. Austin (retired), Medford, Mass.		
L. M. Blake, St. Johnsbury, Vt.		
J. E. Buckley, Nashua, N. H.		
J. P. Canty, Fitchburg, Mass.		
S. P. Coffin, Boston, Mass.		
S. E. Dufort, Lowell, Mass.		
J. H. Fullerton, Woodsville, N. H.		
A. I. Gauthier, Concord, N. H.		
B. W. Guppy, Boston, Mass.		
Andrew B. Hubbard (retired), W. Somerville, Mass.		
Pusey Jones, Boston, Mass.		
F. J. Leavitt, Sanbornville, N. H.		
William A. Lydston (retired), Swampscott, Mass.		
John Marsh, Lawrence, Mass.		
H. C. McNaughton, Concord, N. H.		
Albert Mountfort, Nashua, N. H.		
A. A. Page, Wilmington, Mass.		
E. F. Palmer, Salem, Mass.		
B. F. Pickering, Salem, Mass.		
F. M. Pickering, Salem, Mass.		
E. B. Piper, Concord, N. H.		
E. J. Vatter, Salem, Mass.		
L. N. Wells, Woodsville, N. H.		
F. M. Wherren, Salem, Mass.		
Buffalo, Rochester & Pittsburgh Ry.	4	586
F. A. Benz, E. Salamanca, N. Y.		
E. W. Fair, Du Bois, Pa.		
Chas. Scott, E. Salamanca, N. Y.		
G. H. Stewart, E. Salamanca, N. Y.		
Canadian Northern Ry. System	2	9,295
J. A. Crawford, Saskatoon, Sask.		
A. W. Smith, Winnipeg, Manitoba.		

Name of Road and Membership.	Members.	Mileage.
Canadian Pacific Ry.	2	12,917
Frank Lee, Montreal, Que.		
D. A. McRae, Lethbridge, Alberta.		
Carolina & Northwestern Ry.	1	133
J. W. Fletcher, Chester, S. C.		
Central of Georgia Ry.	2	1,924
J. M. Fitzgerald, Macon, Ga.		
H. C. McKee, Macon, Ga.		
Central Vermont Ry.,	6	536
G. M. Cota, St. Albans, Vt.		
C. Donaldson, St. Albans, Vt.		
C. F. Flint, St. Albans, Vt.		
C. R. Lyman, Waterbury, Vt.		
C. H. Schoolcraft, Farnham, Que.		
W. A. Stewart, New London, Conn.		
Chesapeake & Ohio Ry.,	6	2,374
T. H. Allen, Hinton, W. Va.		
A. C. Copland, Richmond, Va.		
F. M. Griffith, Covington, Ky.		
C. E. Powell, Hinton, W. Va.		
E. J. Rohr, Cincinnati, O.		
J. M. Staten, Richmond, Va.		
Chicago & Eastern Illinois R. R.	1	1,282
A. S. Markley, Danville, Ill.		
Chicago & North Western Ry.,	44	8,102
L. J. Anderson, Escanaba, Mich.		
C. F. Bach, Belle Plaine, Ia.		
H. Bender, Eagle Grove, Ia.		
F. L. Burrell, Fremont, Neb.		
F. M. Case, Belle Plaine, Ia.		
John Cronin, Winona, Minn.		
O. F. Dalstrom, Chicago, Ill.		
T. H. Durfee, Huron, S. D.		
W. H. Finley, Chicago, Ill.		
M. J. Flynn, Chicago, Ill.		
G. W. Hand, Chicago, Ill.		
H. Heiszenbuttel, Norfolk, Neb.		
C. Herrig, Wall Lake, Ia.		
John Hunciker, Chicago, Ill.		
T. J. Irving, Boone, Ia.		
J. W. Irwin, Chadron, Neb.		
W. J. Jackson, Winona, Minn.		
Lee Jutton, Chicago, Ill.		
C. F. King, Omaha, Neb.		
B. R. Kulp, Benld, Ill.		
C. A. Lichty, Chicago, Ill.		
J. A. Lorch, Chicago, Ill.		
George Loughnane, Escanaba, Mich.		
C. A. Marcy, Chicago, Ill.		
J. Mellgren, Eagle Grove, Ia.		
W. F. Meyers, Boone, Iowa.		
C. E. Miller, Chicago, Ill.		
J. W. Miller, Chicago, Ill.		
W. H. Mulcahy, Adams, Wis.		
A. K. Potter, Antigo, Wis.		
J. A. S. Redfield, Fond du Lac, Wis.		

Name of Road and Membership.	Members.	Mileage.
Chicago & North Western Ry. Continued.		
R. W. Richardson, Sioux City, Ia.		
M. Riney, Baraboo, Wis.		
J. S. Robinson, Chicago, Ill.		
D. Rounseville, Chicago, Ill.		
F. E. Shanklin, Belle Plaine, Ia.		
Wm. Spencer, Norfolk, Nebr.		
W. M. Sterling, Chicago, Ill.		
W. M. Sweeney, Green Bay, Wis.		
M. E. Thomas, Boone, Ia.		
R. E. Todd, Madison, Wis.		
O. E. Ullery, Sioux City, Ia.		
I. B. White, Boone, Ia.		
C. F. Womeldorf, Chicago, Ill.		
Chicago, Burlington & Quincy R. R. Co.,	6	9,366
W. E. Elder, Burlington, Ia.		
W. Hurst, Chicago, Ill.		
W. T. Krausch, Chicago, Ill.		
C. J. Scribner, Chicago.		
A. C. Sydell, Chicago, Ill.		
J. O. Thorn, Beardstown, Ill.		
Chicago Great Western R. R.,	4	1,496
W. L. Derr, Clarion, Ia.		
H. H. Eggleston, Des Moines, Ia.		
H. A. Elwell, Clarion, Ia.		
Nels Johnson, St. Charles, Ill.		
Chicago, Indianapolis & Louisville Ry.,	1	654
J. M. Caldwell, Lafayette, Ind.		
Chicago, Milwaukee & St. Paul Ry.,	28	10,667
E. J. Auge, Wells, Minn.		
A. J. Buck, Tacoma, Wash.		
E. E. Clothier, Mobridge, S. D.		
Edw. Collings, Perry, Ia.		
H. R. Drum, Mitchell, S. D.		
W. E. Duckett, Minneapolis, Minn.		
Chas. Gradt, Savanna, Ill.		
L. D. Hadwen, Chicago, Ill.		
F. E. King, Minneapolis, Minn.		
N. H. LaFountain, Chicago, Ill.		
W. R. Lanning, St. Maries, Idaho.		
C. F. Loweth, Chicago, Ill.		
T. E. McFadden, Cedar Falls, Wash.		
Edw. McGuire, Marion, Ia.		
E. S. Meloy, Chicago.		
R. J. Middleton, Chicago, Ill.		
Edw. Murray, Miles City, Mont.		
J. F. Pinson, Seattle, Wash.		
G. T. Richards, Tomah, Wis.		
William Ross, Milbank, S. D.		
E. L. Sinclair, Marion, Ia.		
C. U. Smith, Milwaukee, Wis.		
C. F. Urbutt, Chicago, Ill.		
C. G. Vollmer, Elk Point, S. D.		
Fred E. Weise, Chicago, Ill.		
A. A. Wolf, Milwaukee, Wis.		
William E. Wood, Chicago, Ill.		
A. Yappen, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage
Chicago, Rock Island & Pacific Ry.,	14	7,657
McClellan Bishop, El Reno, Okla.		
G. E. Brooks, Rock Island, Ill.		
J. P. Copp, Haileyville, Okla.		
S. T. Corey, Chicago, Ill.		
C. H. Eggers, Little Rock, Ark.		
A. T. Hawk, Chicago, Ill.		
J. L. Hayes, Rock Island, Ill.		
E. F. Manson, Manly, Ia.		
S. L. McClanahan, Herington, Kans.		
M. D. Miller, Chicago, Ill.		
R. C. Sattley, Chicago.		
A. C. Shields, Trenton, Mo.		
I. L. Simmons, Chicago, Ill.		
R. Wagner, Little Rock, Ark.		
Chicago, St. Paul, Minneapolis & Omaha Ry.,	11	1,750
J. G. Bock, St. Paul, Minn.		
A. F. Gilman, St. Paul, Minn.		
J. F. Glasgow, Worthington, Minn.		
Chas. Mines, Emerson, Neb.		
J. D. Moen, St. Paul, Minn.		
A. G. Rask, Altoona, Wis.		
H. Rettinghouse, St. Paul, Minn.		
Aug. Ruge, Mankato, Minn.		
Chas. Sedmoradsky, Worthington, Minn.		
John Stewart, Spooner, Wis.		
R. R. Strothers, St. Paul, Minn.		
Chicago, Terre Haute & Southeastern Ry.	2	351
J. Dupree, Crete, Ill.		
J. O. Jewell, Terre Haute, Ind.		
Cincinnati, Hamilton & Dayton Ry.,	2	132
R. C. Henderson, Dayton, O.		
A. D. McCallum, Hamilton, O.		
Cincinnati, New Orleans & Texas Pacific Ry.	2	338
F. J. Conn, Lexington, Ky.		
L. A. Cowsert, Danville, Ky.		
Cincinnati Northern R. R.	1	236
J. M. Wilkinson, Van Wert, O.		
Coal & Coke Ry.,	1	197
Wm. Trapnell, Elkins, W. Va.		
Colorado & Southern Ry.,	4	1,089
R. W. Beeson, Trinidad, Colo.		
C. W. Fellows, Denver, Colo.		
Harry James, Denver, Colo.		
A. W. Pauba, Denver, Colo.		
Colorado Midland Ry.	1	338
J. Guretzky, Colorado City, Colo.		
Columbia, Newberry & Laurens R. R.	1	75
A. P. Rice, Columbia, S. C.		
Concho, San Saba & Llano Valley R. R.	1	61
K. S. Hull, Temple, Tex.		

Name of Road and Membership.	Members.	Mileage
Delaware & Hudson Co.,	1	909
N. C. Ailes, Albany, N. Y.		
Delaware, Lackawanna & Western R. R.,	4	981
E. J. Barry, Hoboken, N. J.		
G. E. Boyd, Buffalo, N. Y.		
Albert Fink, Buffalo, N. Y.		
Jas. Skeoch, Dunmore, Pa.		
Denver & Rio Grande R. R.,	4	2,577
A. Ridgway, Denver, Colo.		
H. Taylor, Alamosa, Colo.		
C. S. Thompson, Denver, Colo.		
J. L. Thomson, Salt Lake City.		
Detroit & Mackinac Ry.	1	434
John Owen, East Tawas, Mich.		
Duluth & Iron Range R. R.,	3	197
W. A. Clark, Duluth, Minn.		
O. H. Dickerson, Duluth, Minn.		
B. T. McIver, Two Harbors, Minn.		
Duluth, Missabe & Northern Ry.,	4	356
F. C. Baluss, Duluth, Minn.		
F. N. Graham, Duluth, Minn.		
W. A. McGonagle, Duluth, Minn.		
G. K. Nuss, Proctor, Minn.		
Duluth, South Shore & Atlantic Ry.	1	601
E. R. Lewis, Duluth, Minn.		
Elgin, Joliet & Eastern Ry.	3	770
W. B. Hotson, Joliet, Ill.		
G. H. Jennings, Joliet, Ill.		
A. Montzheimer, Joliet, Ill.		
Erie R. R.,	9	2,257
O. F. Barnes, Jersey City, N. J.		
W. O. Eggleston, Huntington, Ind.		
E. F. Gardner, Buffalo, N. Y.		
A. W. Harlow, Huntington, Ind.		
A. J. Horth, Meadville, Pa.		
F. A. Knapp, Jersey City, N. J.		
Neil McLean, Huntington, Ind.		
Roy Pierce, Salamanca, N. Y.		
W. H. Wilkinson, Elmira, N. Y.		
Florida East Coast Ry.	2	746
E. K. Barrett, St. Augustine, Fla.		
F. J. Thompson, St. Augustine, Fla.		
Fort Smith & Western R. R.	1	217
B. F. Beckman, Ft. Smith, Ark.		
Fort Worth & Denver City Ry.	1	454
J. M. Mann, Ft. Worth, Tex.		
Georgia R. R.,	1	307
J. C. Williams, Decatur, Ga.		
Grand Rapids & Indiana Ry.	2	592
H. M. Large, Ft. Wayne, Ind.		
W. S. McKeel, Grand Rapids, Mich.		

Name of Road and Membership.	Members.	Mileage.
Grand Trunk Ry. System,	16	4,735
W. Cayley, Stratford, Ont.		
J. B. Gaut, Chicago, Ill.		
J. Henderson, St. Thomas, Ont.		
J. Innes, Hamilton, Ont.		
J. H. Johnston, Montreal, Que.		
G. C. McCue, Ottawa, Ont.		
George A. Mitchell, Toronto, Ont.		
F. P. Sisson, Detroit, Mich.		
Jos. Spencer, Stratford, Ont.		
H. B. Stuart, Montreal, Que.		
H. C. Swartz, St. Thomas, Ont.		
W. G. Swartz, Campbellford, Ont.		
W. H. Tichbourne, London, Ont.		
W. J. Tyers, Belleville, Ont.		
C. F. Warcup, St. Thomas, Ont.		
J. Wilson, Hamilton, Ont.		
Grand Trunk Pacific Ry.	1	3,627
L. H. Wheaton, Dartmouth, N. S.		
Great Northern Ry.,	2	8,102
J. A. Bohland. St. Paul, Minn.		
H. A. Gerst, St. Paul, Minn.		
Gulf, Colorado and Santa Fe Ry.	5	1,937
Z. A. Green, Galveston, Tex.		
K. S. Hull, Temple, Tex.		
G. A. Knapp, Galveston, Tex.		
W. G. Massenburg, Beaumont, Tex.		
W. W. Wilson, Galveston, Tex.		
Illinois Central R. R.,	13	4,767
P. Aagaard, Chicago, Ill.		
Chas. Dale, New Orleans, La.		
F. O. Draper, Chicago, Ill.		
C. Ettinger, Chicago, Ill.		
Maro Johnson, Chicago, Ill.		
C. R. Knowles, Chicago, Ill.		
O. W. Lentz, Chicago, Ill.		
S. P. Munson, Mattoon, Ill.		
W. L. Ratliff, McComb, Miss.		
M. A. Smith, New Orleans, La.		
O. M. Suter, Chicago, Ill.		
F. L. Thompson, Chicago, Ill.		
E. F. Wise (retired), Waterloo, Ia.		
Illinois Traction System	2	425
G. W. Black, Mackinaw, Ill.		
G. A. Wright, Decatur, Ill.		
Imperial Govt. Rys. of Japan	1	1,000
S. Kurokochi, Tokyo, Japan.		
International & Great Northern Ry.	1	1,106
H. M. Jack, Palestine, Tex.		
Kansas City, Clinton & Springfield Ry.	1	155
J. B. Browne, Clinton, Mo.		
Kansas City Southern Ry.	3	826
W. W. Casey, Texarkana, Tex.		
C. E. Johnston, Kansas City, Mo.		
J. J. Taylor, Texarkana, Tex.		

Name of Road and Membership.	Members.	Mileage.
Lake Erie & Western R. R.,	1	882
P. P. Lawrence, Tipton, Ind.		
Lake Superior & Ishpeming Ry., Munising, Marquette & S. E. Ry.	2	160
August Anderson, Marquette, Mich.		
Roscoe C. Young, Marquette, Mich.		
Lehigh & Hudson River Railway	1	96
J. E. Barrett, Warwick, N. Y.		
Lehigh & New England R. R.	1	296
A. M. Snyder, Pen Argyl, Pa.		
Lehigh Valley R. R.,	10	1,443
E. B. Ashby, New York City.		
Peter Hofecker, Auburn, N. Y.		
J. W. Holcomb, Buffalo, N. Y.		
R. E. James, Sayre, Pa.		
Judson Joslin, Auburn, N. Y.		
A. E. Kemp, Hazleton, Pa.		
F. E. Schall, South Bethlehem, Pa.		
L. W. Swan, Easton, Pa.		
E. R. Wenner, Ashley, Pa.		
F. W. White, Wilkes-Barre, Pa.		
Long Island R. R.	8	399
E. L. Goldsmith, Jamaica, N. Y.		
Wm. G. Hicks, Jamaica, N. Y.		
M. Loeffler, Jamaica, N. Y.		
W. F. O'Connor, Flushing, N. Y.		
E. P. Self, Jamaica, N. Y.		
Chas. Wehlen, Jamaica, N. Y.		
W. Wicks, Amityville, N. Y.		
C. W. Wright, Jamaica, N. Y.		
Los Angeles & Salt Lake R. R.	5	1,100
D. H. Ashton, Salt Lake City, Utah.		
F. M. Bigelow, Salt Lake City, Utah.		
R. R. Bishop, Salt Lake City, Utah.		
W. C. Frazier, Los Angeles, Cal.		
J. C. Post, Los Angeles, Cal.		
Louisiana & Arkansas Ry.,	1	302
D. Zenor, Stamps, Ark.		
Louisville & Nashville, R. R., (and Nash. Term. Co.)	12	5,070
J. M. Bibb, Birmingham, Ala.		
A. J. Catchot, Ocean Springs, Miss.		
R. O. Elliott, Nashville, Tenn.		
H. R. Hill, Birmingham, Ala.		
Floyd Ingram, Erin, Tenn.		
T. H. King, Knoxville, Tenn.		
J. W. Little, Birmingham, Ala.		
A. B. McVay, Evansville, Ind.		
C. M. Roy, Birmingham, Ala.		
Wm. Sheley, Evansville, Ind.		
H. Stamler, Paris, Ky.		
W. G. Stewart, Nashville, Tenn.		
Louisiana & Northwest R. R.,	1	121
T. R. Barger, Homer, La.		

Name of Road and Membership.	Members.	Mileage.
Maine Central R. R.	1	1,206
P. N. Watson, Brunswick, Me.		
Michigan Central R. R.,	13	1,800
S. D. Bailey, Detroit, Mich.		
Grant Boyer, Detroit, Mich.		
G. H. Fenwick, St. Thomas, Ont.		
Thomas Hall, St. Thomas, Ont.		
F. J. Hodges, Jackson, Mich.		
Henry A. Horning, Jackson, Mich.		
J. S. Huntoon, Detroit, Mich.		
Andrew Leslie, St. Thomas, Ont.		
A. B. Nies, Jackson, Mich.		
W. H. Sellew, Detroit, Mich.		
E. W. Smith, Detroit, Mich.		
S. B. Thorn, Bay City, Mich.		
Geo. H. Webb, Detroit, Mich.		
Minneapolis & St. Louis R. R.	2	1,645
Ed. Gagnon, Minneapolis, Minn.		
G. S. Kibbey, Minneapolis, Minn.		
Minneapolis, St. Paul & Sault Ste. Marie Ry.,	3	4,020
O. C. Gongoll, Minneapolis, Minn.		
G. A. Manthey, Minneapolis, Minn.		
P. Swenson, Minneapolis, Minn.		
Mississippi Central R. R.	1	150
L. E. Faulkner, Hattiesburg, Miss.		
Miss. River & Bonne Terre Ry.	1	64
C. H. Fake, Bonne Terre, Mo.		
Missouri, Kansas & Texas Lines,	1	3,865
A. S. Clopton, Oklahoma City, Okla.		
Missouri, Oklahoma & Gulf Ry.	1	334
Chas. Harrison, Muskogee, Okla.		
Missouri Pacific R. R.,	29	7,293
E. E. Allard, St. Louis, Mo.		
T. H. Bridges, McGehee, Ark.		
Robert J. Bruce, St. Louis, Mo.		
W. L. Burnett, Eudora, Ark.		
J. E. Byrd, McGehee, Ark.		
W. E. Byrd, McGehee, Ark.		
H. W. Clark, Falls City, Nebr.		
A. H. Ferdina, St. Louis, Mo.		
C. Gnadt, Poplar Bluff, Mo.		
W. A Guire, Lake Providence, La		
Lon Graves, Dermott, Ark.		
J. C. Hargrove, McGehee, Ark.		
E. H. Harvey, Montrose, Ark.		
W. Hausgen, Sedalia, Mo.		
E. P. Hawkins, McGehee, Ark.		
E. A. Jackson, McGehee, Ark.		
W. J. Lacy, Poplar Bluff, Mo.		
C. W. Lamb, Pine Bluff, Ark.		
G. W. Land, McGehee, Ark.		
A. D. May, Little Rock, Ark.		

Name of Road and Membership.	Members.	Mileage.
Missouri Pacific R. R., continued.		
J. V. Reynolds, McGehee, Ark.		
D. L. Roper, Monroe, La.		
C. C. Runyon, Gorham, Ill.		
Wm. Smith, McGehee, Ark.		
Wm. Sullivan, Kansas City, Mo.		
F. W. Tanner, St. Louis, Mo.		
D. G. Tewksbury, Gorham, Ill.		
L. J. Wackerle, Osawatomie, Kans.		
A. L. Waits, St. Louis, Mo.		
Mobile & Ohio R. R.	1	1,122
W. B. Harris, Corinth, Miss.		
Morgan's La. & Tex. R. R. & S. S. Co.,	3	405
A. B. Ashmore, Lafayette, La.		
H. F. Jonas, Houston, Tex.		
H. Slabotsky, Lafayette, La.		
Nashville, Chattanooga & St. Louis Ry.	5	1,230
W. H. Fletcher (Retired), Nashville, Tenn.		
H. P. Hodges, Nashville, Tenn.		
Hunter McDonald, Nashville, Tenn.		
O. M. Sorrells, Atlanta, Ga.		
I. O. Walker, Atlanta, Ga.		
New Orleans & North Eastern R. R.,	4	196
L. E. Jones, New Orleans, La.		
O. R. McIlhenny, Laurel, Miss.		
J. S. Sharp, New Orleans, La.		
J. J. Steadham, New Orleans, La.		
New Orleans Great Northern	1	285
F. J. Bourgeois, Bogalusa, La.		
New Orleans, Mobile & Chicago R. R.	1	403
P. K. Lütken, Laurel, Miss.		
New Orleans, Texas & Mexico R. R.	1	287
J. P. Yates, DeQuincy, La.		
New South Wales Government Rys.,	1	3,967
James Fraser, Sydney, N. S. W.		
New York Central R. R.,	17	5,032
J. K. Bonner, Rochester, N. Y.		
W. S. Haley, Toledo, O.		
U. S. Hitesman, New York City.		
G. J. Klumpp, Rochester, N. Y.		
R. P. Mills, New York City.		
Philip O'Neill, Adrian, Mich.		
Kemper Peabody, N. Y. City.		
W. A. Pettis, Rochester, N. Y.		
R. H. Reid, Cleveland, O.		
E. J. Rykenboer, Rochester, N. Y.		
S. A. Seely, Utica, N. Y.		
J. L. Soisson, Norwalk, O.		
W. F. Steffens, New York City.		
L. W. Stone, Oswego, N. Y.		
E. R. Tattershall, Malone, N. Y.		
H. C. Thompson, Weehawken, N. J.		
E. E. Wilson, New York City.		

Name of Road and Membership.	Members.	Mileage.
New York, New Haven & Hartford R. R.	18	2,003
C. L. Beeler, New Haven, Conn.		
J. S. Browne, New Haven, Conn.		
Eldridge E. Candee, New London, Conn.		
Elliot E. Candee, Waterbury, Conn.		
H. H. Kinzie, Taunton, Mass.		
A. G. McKay, New Haven, Conn.		
W. V. Lattin, Hartford, Conn.		
E. C. Littlefield, New Haven, Conn.		
Wm. H. Moore, New Haven, Conn.		
E. O. Newton, Danbury, Conn.		
B. P. Phillips, Willimantic, Conn.		
L. H. Porter (retired), Andover, Conn.		
George A. Rodman, New Haven, Conn.		
George T. Sampson, Boston, Mass.		
W. B. Schuessler, Waterbury, Conn.		
D. W. Sharpe (Retired), New Haven, Conn.		
J. B. Sheldon, Providence, R. I.		
J. J. Wishart, Boston, Mass.		
New York, Ontario & Western Ry.	1	494
J. H. Nuelle, Middletown, N. Y.		
Northern Ry. (Costa Rica),	1	375
M. M. Marsh, Squirres, Costa Rica, C. A.		
Northern Pacific Ry.,	4	6,727
E. H. Brown, Minneapolis, Minn.		
James Hartley, Staples, Minn.		
F. Ingalls, Jamestown, N. D.		
C. S. McCully, Jamestown, N. D.		
Northwestern Pacific R. R.,	1	469
A. A. Robertson, San Rafael, Cal.		
Oakland, Antioch & Eastern Ry.	1	115
W. B. Noland, Sacramento, Cal.		
Oregon Short Line R. R.	26	2,256
E. S. Airmet, Salt Lake City, Utah.		
L. W. Althof, Pocatello, Idaho.		
N. D. Brookhart, Pocatello, Idaho.		
F. P. Cullen, Pocatello, Idaho.		
J. F. Cullen, Pocatello, Idaho		
E. A. Demars, Salt Lake City, Utah.		
I. A. Draper, Pocatello, Idaho.		
Fred Gaunt, Pocatello, Idaho.		
Rupert Hansen, Salt Lake City, Utah.		
C. J. Harris, Roberts, Idaho.		
C. A. Harshbarger, Ontario, Ore.		
J. A. Kelly, Pocatello, Idaho.		
A. H. King, Pocatello, Idaho.		
Roy McRostie, Pocatello, Idaho.		
C. T. Musgrave, Idaho Falls, Idaho.		
R. Newton, Pocatello, Idaho.		
P. E. Parsons, Salt Lake City, Utah.		
E. E. Paterson, Pocatello, Idaho.		
C. G. Pitcher, Pocatello, Idaho.		
S. J. Powell, Ogden, Utah.		
A. W. Robinson, Salt Lake City, Utah.		

Name of Road and Membership.	Members.	Mileage.
Oregon Short Line R. R. Continued.		
R. B. Robinson, Salt Lake City, Utah.		
Parker Shifflet, Pocatello, Idaho.		
Wm. Sorensen, Brigham, Utah.		
A. R. Stevens, Pocatello, Idaho.		
D. T. Wells, Salt Lake City, Utah.		
Pacific Electric Ry.,	6	1,047
Alf Brown, Los Angeles.		
C. F. Estes, Los Angeles, Cal.		
B. F. Manley, Los Angeles, Cal.		
D. E. Plank, Los Angeles, Cal.		
J. R. Shean, Los Angeles, Cal.		
J. F. Zorn, Los Angeles, Cal.		
Pennsylvania Lines West of Pittsburgh	9	4,161
T. O. Andrews, Lebanon, Ind.		
Samuel C. Bowers, Steubenville, O.		
B. F. Gehr, Richmond, Ind.		
A. F. Miller, Chicago, Ill.		
D. G. Musser, Wellsville, O.		
H. H. Pollock, Carnegie, Pa.		
W. F. Rankin, Cambridge, O.		
J. Wallenfelsz, Cambridge, O.		
D. C. Zook, Fort Wayne, Ind.		
Pennsylvania R. R.	4	5,379
M. M. Barton (Retired), W. Philadelphia, Pa.		
H. R. Leonard, Philadelphia, Pa.		
Robert McKibben, Altoona, Pa.		
A. W. Reynolds, Jersey City, N. J.		
Pere Marquette R. R.	14	2,262
J. D. Black, Saginaw, Mich.		
Thos. Brown, Saginaw, Mich.		
J. J. Evans, Saginaw, Mich.		
Edw. Guild, Grand Ledge, Mich.		
G. E. Hanks (retired), East Saginaw, Mich.		
C. H. Johnson, Reese, Mich.		
A. L. McCloy, Reese, Mich.		
A. McNab, Holland, Mich.		
Homer Morgan, Greenville, Mich.		
John Robinson, Grand Rapids, Mich.		
J. E. Toohey, Grand Rapids, Mich.		
C. F. Weir, St. Thomas, Ont.		
G. Y. Whitmee, Grand Rapids, Mich.		
J. P. Wood, Saginaw, Mich.		
Philadelphia & Reading Ry.	5	1,582
Amos H. Beard (retired), Reading, Pa.		
Franklin Gable, Catawissa, Pa.		
G. M. Hoffman, Shamokin, Pa.		
E. G. Storck, Philadelphia, Pa.		
E. E. Templin, Pottsville, Pa.		
Pittsburgh & Lake Erie R. R.	1	224
D. L. McKee, McKee's Rocks, Pa.		
San Antonio & Aransas Pass Ry.	2	724
F. W. Bailey, Yoakum, Tex.		
J. D. Lacy, Houston, Tex.		

Name of Road and Membership.	Members.	Mileage.
Seaboard Air Line Ry.,	6	3,449
C. F. Ballard, Peachland, N. C.		
J. E. Eubanks, Yulee, Fla.		
W. J. Galloway, Hamlet, N. C.		
W. A. McDearmid, Charleston, S. C.		
J. C. Nelson, Norfolk, Va.		
J. L. Winter, Waldo, Fla.		
St. Joseph & Grand Island Ry.,	2	258
Wm. Carmichael, St. Joseph, Mo.		
G. T. Ray, Marysville, Kans.		
St. Louis & San Francisco R. R.	1	4,740
F. G. Jonah, St. Louis, Mo.		
St. Louis Southwestern Ry.,	4	1,685
J. S. Berry, St. Louis, Mo.		
W. V. Parker, Malden, Mo.		
Wm. Quinn, Tyler, Tex.		
W. H. Vance, Tyler, Tex.		
Shreveport, Alexandria & S. W. Ry.,	1	138
W. Vandercook, Lake Charles, La.		
Southern Ry.,	7	7,922
R. E. Connor, Columbia, S. C.		
N. L. Hall, Greensboro, N. C.		
J. S. Lemond, Charlotte, N. C.		
C. A. Redinger, Old Fort, N. C.		
T. E. Sharpe, Greenville, S. C.		
J. B. Teaford, Louisville, Ky.		
G. W. Welker, Alexandria, Va.		
Southern New England Ry.,	3	85
J. E. Cole, Providence, R. I.		
R. D. Garner, Providence, R. I.		
W. A. Leach, Providence, R. I.		
Southern Pacific Company,	67	6,950
H. L. Archbold, Los Angeles, Cal.		
T. W. Bratten, Oakland Pier, Cal.		
C. W. Brown, Mina, Nev.		
H. Bulger, Oakland Pier, Cal		
F. L. Burckhalter, Portland, Ore.		
W. H. Burgess, Stockton, Cal.		
D Burke, Tucson, Ariz.		
W. E. Burns, San Francisco, Cal.		
J. T. Caldwell, Bakersfield, Cal.		
J. H. Clark, Los Angeles, Cal.		
W. S. Corbin, San Pedro, Cal.		
D. M. Crosman, Los Angles, Cal.		
Geo. Dickson, Oakland, Cal.		
F. C. Dittmar, Los Angeles, Cal.		
R. M. Drake, San Francisco, Cal.		
G. A. Easton, West Oakland, Cal.		
B. F. Ferris, Los Angeles, Cal.		
J. F. Fisher, Sacramento, Cal.		
M. Fisher, Ogden, Utah.		
A. Fraser, Bakersfield, Cal.		
Neil Fraser, Dunsmuir, Cal.		
Ira Gentis, Oakland, Cal.		

Name of Road and Membership.	Members.	Mileage.
Southern Pacific Company. Continued.		
P. Giusto, San Francisco, Cal.		
J. A. Given, Sacramento, Cal.		
Jas. Gratto, Los Angeles, Cal.		
C. F. Green, Sacramento, Cal.		
H. A. Hampton, Portland, Ore.		
Robt. Hansen, West Oakland, Cal.		
W. C. Harman, Bakersfield, Cal.		
J. M. Hinchee, Los Angeles, Cal.		
J. A. Hutchens, Ogden, Utah.		
Jno. D. Isaacs, New York City.		
C. A. Jensen, Los Angeles, Cal.		
H. Lodge, San Francisco, Cal.		
C. W. McCandless, Ventura, Cal.		
J. C. McClure, Los Angeles, Cal.		
D. McGee, Sacramento, Cal.		
A. M. McLeod, Oakland, Cal.		
J. B. Malloy, San Francisco, Cal.		
J. D. Mathews, Tucson, Ariz.		
F. D. Mattos, W. Oakland, Cal.		
M J Mayer, San Francisco, Cal.		
A. T. Mercier, Los Angeles, Cal.		
E. C. Morrison, San Francisco, Cal.		
J J. Murphy, Oakland, Cal.		
R. E. Murphy, Bakersfield, Cal.		
P. N. Nelson, San Francisco, Cal.		
Harry Pollard, San Francisco, Cal.		
Homer Pollard, West Oakland, Cal.		
Geo. W. Rear, San Francisco, Cal.		
J. S. Replogle, Oakland, Cal.		
D. B. Rich, Stockton, Cal.		
D. T. Rintoul, Bakersfield, Cal.		
Norman Rose, Portland, Ore.		
W. M. Rose, Sacramento, Cal.		
Niles Searls, San Francisco, Cal.		
Fred Secord, Sacramento, Cal.		
G. W. Sedwell, Bakersfield, Cal.		
T. H. Settle, Los Angeles, Cal.		
F. M. Siefer, Sacramento, Cal.		
C. W. Smith, Portland, Ore.		
Thos. Tretheway, Stockton, Cal.		
W. F. Turner, Ogden, Utah.		
E. J. Vincent, Los Angeles, Cal.		
A. Weldon, Bakersfield, Cal.		
C. R. Wells, Sacramento, Cal.		
M. M. Wilson, Los Angeles, Cal.		
South Manchuria Ry..	1	2,000
Y. Maruyama, Dairen, Japan.		
Temiskaming & Northern Ontario Ry..	2	320
G. H. Dickson, North Bay, Ont.		
W. J. Oldham, North Bay, Ont.		
Texas & Pacific Ry.	1	1,944
E. Loughery, Dallas, Tex.		
Texas Midland R. R.	1	125
E. H. R. Green, Terrell, Tex.		
The Thousand Islands Ry.	1	20
H. A. Cooper, Gananoque, Ont.		

Name of Road and Membership.	Members.	Mileage.
Toledo, Peoria & Western Ry.	1	248
J. H. Markley, Peoria, Ill.		
Toledo Railways & Light Co.,	1	110
A. Swartz, Sylvania, O.		
Trinity & Brazos Valley Ry.,	2	466
B. M. Hudson, Teague, Tex.		
R. W. Smith, Teague, Tex.		
Union Pacific System	1	7,825
J. Parks, Denver, Colo.		
Union Traction Co. of Ind.	2	460
Jno. Hancock, Anderson, Ind.		
L. A. Mitchell, Anderson, Ind.		
Wabash R. R.	3	2,519
A. O. Cunningham, St. Louis, Mo.		
E. C. Danes, Peru, Ind.		
William S. Danes, Peru, Ind.		
Washington Terminal Co.,	1	53
W. M. Cardwell, Washington, D. C.		
Western & Atlantic R. R.	1	137
D. E. Counts, Dalton, Ga.		
Western Australia Government Rys.	1	1,943
E. S. Hume, Midland Jct., Western Australia.		
Western Pacific Ry.	1	946
T. J. Stuart, Elko, Nev.		
Wheeling & Lake Erie R. R.	3	459
Wm. Mahan, Canton, O.		
W. L. Rohbock, Cleveland, O.		
Yazoo & Miss. Valley R. R.	2	1,370
D. H. Holdridge, Vicksburg, Miss.		
W. Shropshire, Greenville, Miss.		

No. of Railroads Represented,	129	
Total, Members and Mileage,	636	251,945
Members not with Railroads,	69	
Total Membership,	705	

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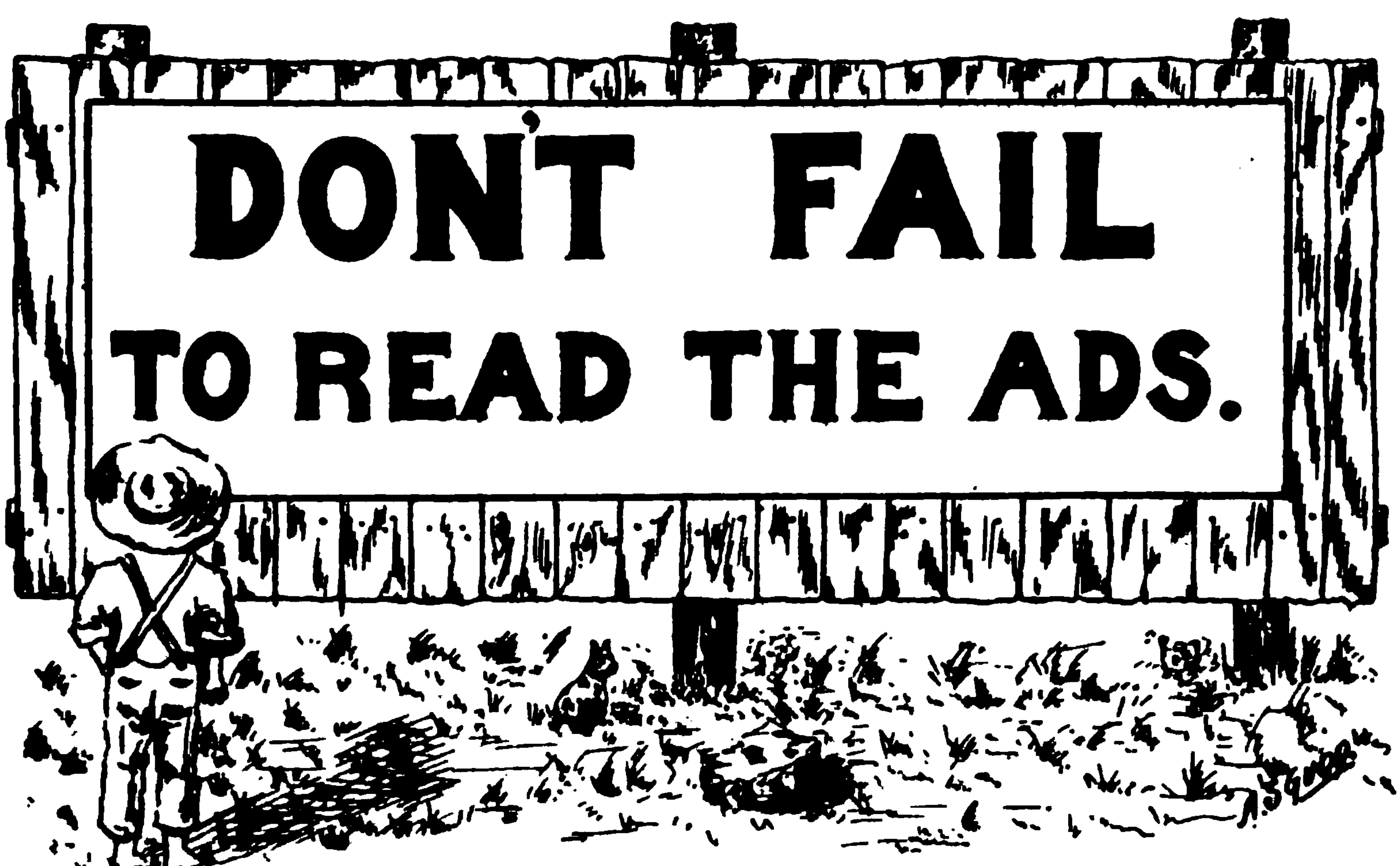

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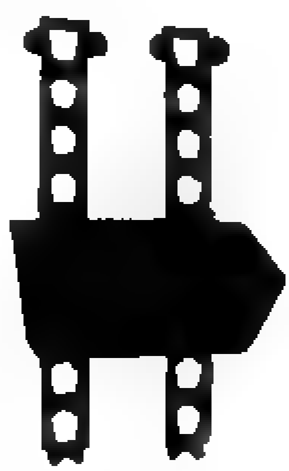

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PROCEEDINGS OF THE

Twenty-Eighth Annual Convention

OF THE

American Railway Bridge and Building Association

HELD AT

CHICAGO, ILL.

October 15-17, 1918

REPORTS IN THIS ISSUE

Repairing and Strengthening Old Masonry
Sources of Water Supply
Wooden Tanks
Bridge Decks and Guards
Shipping Material Economically
Essential Work
Carrying Bridges Over
Labor Saving Devices
Factory Made Concrete
Conservation of Material
Small versus Large Gangs

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PUBLISHED BY THE ASSOCIATION
C. A. Lichty, Secretary
319 NO. WALLER AVENUE
CHICAGO, ILL.

LEE JUTTON

Division Engineer, C. & N. W. Ry.,
President, 1919

CALVIN A. LICHTY

Secretary-Treasurer

PROCEEDINGS OF THE

Twenty-Eighth Annual Convention

OF THE

American Railway Bridge and Building Association

Successor to the

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS

HELD AT

CHICAGO, ILL.

OCTOBER 15-17, 1918

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J. P. Wood, P. M. R. R., Saginaw, Mich.

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Proceedings of the Twenty-eighth Annual Convention
of the

American Railway Bridge and Building Association

Held at the Hotel Sherman

Chicago, Ill., October 15-17, 1918

The twenty-eighth annual convention of the American Railway Bridge and Building Association was called to order in the Louis XVI room of the Hotel Sherman, Chicago, at 10:30 o'clock Tuesday, October 15, 1918, by President S. C. Tanner.

The President:—Following the established custom we will open the meeting with prayer. I will call on the secretary to offer prayer.

Invocation by Secretary Lichty.

The President:—It has been customary to have an address of welcome by the mayor of the city and from some prominent railroad man, followed by a response from one of our members, and while this was interesting and entertaining it was thought best to dispense with such items during the war. Conditions are different from what they were several years ago and instead of "talk and entertain" it is now "business and action." We have therefore decided to cut out at this time all matters of entertainment. Business will predominate in these sessions and we will cut the preliminaries short.

It has been the custom to have an address from the president and he has deemed it wise to cut this to a minimum and "clear the deck for action."

I do not want to allow the opportunity to pass without commenting on the attendance, which, although not as large as in other recent years, is fully as good or better than we could expect, all

things considered. It shows the loyalty of our members to the National Government and to the railroads which we represent. Your attendance at these meetings is an indication of patriotism because you come to spread broadcast knowledge pertaining to the best and most economical methods of practice pertaining to the construction and maintenance of railroad bridges, buildings and water supply.

I believe I am safe in saying, and that you will agree with me. that the railroads are the fathers of industry in this country and that the tracks, bridges and buildings are the grandparents of the railroads. It is almost impossible to comprehend the great importance and value of the 252,000 miles of the railroads to our Government and our allies at the present time in transporting troops, munitions and supplies. Our members are vitally interested in maintaining the roads in the best possible shape, both in this country and abroad, and this is much more difficult at the present time on account of the scarcity of labor and materials which confronts us on every hand in all parts of the country. It is therefore proper that we should meet and discuss these matters which pertain to the conservation of labor and material and to recommend methods of saving labor and all manner of mechanical labor saving devices. (Applause.)

We will now proceed with the regular order of business.

The reading of the minutes of the previous meeting will be dispensed with as they have been published and placed in the hands of all the members. The report of the executive committee will also be dispensed with for the same reason. The next in order is roll call.

The Secretary:—Most of you are familiar with the method we use to secure the registration of members present at the convention. Registration cards are to be found at the desk just outside the door. We urge all present to register in order that we may be able to show the full attendance.

The registration showed the following members to be present:

P. Aagaard
W. E. Alexander
L. J. Anderson
S. D. Bailey
F. C. Baluss
H. Bender
M. Bishop
S. C. Bowers
G. U. Boyer
Geo. E. Brooks
R. J. Bruce
J. M. Caldwell
W. M. Camp
F. M. Case
E. E. Clothier
E. Collings
F. J. Conn
John Cronin
O. F. Dalstrom
E. A. Demars
W. L. Derr
J. Dupree
C. H. Eggers
Chas. Esping
Chas. Ettinger
R. F. Farlow
W. H. Finley
M. J. Flynn
B. F. Gehr
Ira Gentis

H. A. Gerst
Chas. Gradt
F. N. Graham
Edw. Guild
L. D. Hadwen
Thos. Hall
A. W. Harlow
R. C. Henderson
H. A. Horning
Wm. B. Hotson
E. T. Howson
J. Hunciker
J. S. Huntoon
W. J. Jackson
A. J. James
Nels Johnson
Lee Jutton
C. W. Kelly
A. H. King
C. R. Knowles
G. W. Land
T. S. Leake
E. R. Lewis
C. A. Lichty
M. Loeffler
Geo. Loughnane
A. S. Markley
E. M. McCabe
Edward McGuire
R. McKibben
A. McNab
J. W. Miller
M. D. Miller
L. A. Mitchell
A. Montzheimer
R. E. Murphy
G. K. Nuss
P. J. O'Neill
J. F. Parker
K. Peabody
J. A. S. Redfield
R. H. Reid
H. Rettinghouse
G. S. Richards
R. W. Richardson
M. Riney
J. S. Robinson
W. A. Rogers
D. Rounseville
R. C. Sattley
F. E. Schall
C. J. Scribner
L. T. Seeley
A. C. Shields
I. L. Simmons
R. W. Smith
Jos. Spencer
W. M. Sterling
H. B. Stuart
Wm. Sullivan
O. M. Suter
H. C. Swartz
W. M. Sweeney
P. Swenson
S. C. Tanner
D. B. Taylor
M. E. Thomas
E. E. R. Tratman
T. B. Turnbull
C. G. Vollmer
H. von Schrenk
C. F. Warcup
F. E. Weise
J. B. White
M. R. Williams
A. A. Wolf
C. F. Womeldorf
J. P. Wood
J. W. Wood
A. Yappen

The following persons subsequently elected to membership were also present:

C. N. Bainbridge
W. A. Batey
F. A. Eskridge
Wm. James
Geo. F. Porter
F. H. Soothill
T. G. Sughrue
R. Kendall
A. C. Roberts

Total number of members registered, 119.

The past presidents in attendance were A. S. Markley, W. A. Rogers, A. Montzheimer, C. A. Lichty, R. H. Reid, H. Rettinghouse, F. E. Schall, and L. D. Hadwen.

The President:—I will appoint F. E. Weise assistant secretary for the duration of the convention.

We will now have the report of the secretary-treasurer.

REPORT OF THE SECRETARY-TREASURER

There is no doubt but that the Association is passing through the most strenuous period in its history. Labor conditions on the railroads are the reverse of what they had been for many years past and at the present time the question of help is the source of a great deal of worry to those who have the hiring of men of nearly all classes. Many of our members who have been regular in attendance at our conventions in past years are unable to be present at this meeting on account of the depletion of their forces, making it necessary for them to remain in close proximity to their work.

Several of our members are engaged in active military service; a number of others are in the vicinity of Washington or in the various shipbuilding yards all along the coast. Many of our members have given up good positions to offer their services to the nation. The man

who so ably presided at our convention last year (in this room) turned his fine engineering practice over to others and is now a major in the national service. We have from among our members a number of majors, two lieutenant colonels and others of lesser rank in the service.

Our association has received favorable consideration from the railroad administration and we have not been handicapped in any manner in carrying out our work which we deem so important at this time to our members, our fellow workmen and the railroads which we represent. Everything considered, it may be said that our association is in a healthy and prosperous condition. Our membership is keeping up fully as well as could be expected, yet it is true that there are many large roads from which we have no representatives and others from which we have only one or two. Our members are keeping up their dues fully as well as in other years. Our dues have not been raised and while for several years past we have not kept even,—gradually reducing our surplus in the treasury—we are able this year to show a balance on the right side of the ledger. We have perhaps the lightest dues of any similar organization in the country and if our members will pay up promptly in the future it may not become necessary to increase them while we will also be enabled to meet our obligations without drawing on our reserve which is now in the vicinity of $900. It is gratifying to know that many of our old members who have attained the highest ranks in railroad service "stand by the old ship" and continue to say words of praise for the work accomplished by the association. While most of us are doing our "bit" many are doing their best,—in committee work, soliciting new members, securing advertisements or perhaps speaking a good word here and there for the association wherever and whenever they can. It is impossible for the secretary and the other officers to carry the entire load and make the outcome a success.

While we have not received notice of any fatalities among those who are engaged in military service the grim reaper has been busy in our ranks and our roll has suffered the loss of eleven members by death, due recognition of which will be made by the obituary committee as well as by the publication of fitting memoirs in our proceedings each year where the information is available.

A separate memorial volume of 93 pages was published and distributed during the past year on the life of the lamented "Deacon" S. F. Patterson who was perhaps the most unique character in the history of the association. Further reference will be made by the special memorial committee.

Upon the action of the convention at its meeting a year ago congratulations were sent to our member, Mr. Phelps Johnson, president of the St. Lawrence Bridge Co., upon the successful completion of the world's greatest bridge at Quebec in reply to which a letter of appreciation was received which will appear in the minutes of this convention.

The regular number of copies of the proceedings of the last meeting (1200) was published and distributed,—800 copies being bound in cloth and 400 in paper covers.

It has been the custom in the past to furnish the leading libraries of cities and colleges with our publications and this custom is still in vogue.

The financial report follows:

Chicago, October 14, 1918.

Financial

Balance on hand at last report ....$ 957.79

Receipts

Dues and fees	$1,159.00	
Advertising	1,203.60	
Sale of badges	7.25	
Sale of books	21.55	
Interest	48.00	
Total receipts		$2,439.40
Total on hand and received		$3,397.19

Disbursements

Postage	$ 121.35	
Printing and engraving	1,191.47	
Stationery and office supplies	21.85	
Editing	70.00	
Stenographer	90.00	
Expenses various committees	6.00	
Badges	11.73	
Salaries and office rent	800.00	
Convention expenses	22.70	
Telephone and telegraph	2.30	
Miscellaneous	16.00	
Total disbursements		$2,353.40
Balance on hand Oct. 14, 1918		$1,043.79

Of the above amount $800 has been loaned out on first mortgage notes at 6 per cent and the balance of $243.79 is on hand in the bank.

Respectfully submitted, C. A. Lichty, Secy-Treas.

The report was accepted and the president appointed R. C. Sattley, J. S. Robinson and M. Riney to audit the books and accounts of the secretary-treasurer. The president also appointed a committee on resolutions consisting of F. E. Schall, J. P. Wood, and P. J. O'Neill. Several announcements were made, after which the ladies were permitted to retire from the hall.

The President:—We will now have the report of the committee on membership.

REPORT OF MEMBERSHIP COMMITTEE

During the year a circular letter was issued similar to the one used last year which was sent out with application blanks. The committee received very good support from individual members and new members were secured from all parts of the country. A great deal can yet be done in securing new members for there are several large railroads which have few or no representatives in the association.

Despite the fact that it was a difficult year, for many reasons, to get new members the committee is able to submit for your approval the attached list of 48 applicants.

E. M. McCabe,
N. C. Ailes,
A. W. Reynolds,
J. K. Bouner,
A. H. King,
Committee.

LIST OF APPLICANTS FOR MEMBERSHIP

Alexander, S. Y., Gen. For. B. & B., St. L. B. & M., Kingsville, Tex.
Bainbridge, C. N., Asst. Engr., C. M. & St. P., Chicago.
Batey, W. A. Supv. B. & B., U. P., Kansas City, Mo.
Bennett, D. E., For. B. & B., Mo. Pac., De Soto, Mo.
Busier, T. W., Plumb. For., B. & A., Pittsfield, Mass.
Caldwell, C. H., For. B. & B., Sou. Pac., E. Bakersfield, Cal.
Colclough, E., Gen. For. B. & B., A. T. & S. F., Fresno, Cal.
Creeks, J. L., For. B. & B., Sou. Pac., Dunsmuir, Cal.
Curry, Jno., For. B. & B., Mo. Pac., McGehee, Ark.
de Ximeno, A., C. C. S. C., Obispo 59 altos, Havana, Cuba.
Dillabough, J. V., Asst. Dist. Eng., C. N. Edmonton, Alberta.
Eskridge, F. A., Archt., C. & E. I., Chicago, Ill.
Frazer, H. H., Div. For. W. & F. Service, S. P., Dunsmuir, Cal.
Golson, W. P., Roadmaster, C. of Ga., Macon, Ga.
Griffith, W. J., Mas. For., B. & A., Pittsfield, Mass.
Haag, Orin, Carp. For., B. & O., Garrett, Ind.
Hartwell, J. R., Supv., P. R. C. & N. W., Pierre, S. D.
Harvey, T. J., Br. Insp., B. & A., Pittsfield, Mass.
Hillman, F. W., Div. Engr., C. & N. W., Madison, Wis.
James, Wm., Carp. For., I. C., New Orleans, La.
Kendall, R., Mast. Carp., C. & W. I., Chicago.
Little, C. A., Div. For. B. & B., B. & M., Concord, N. H.
McMahon, G., For. B. & B., Sou. Pac., Dunsmuir, Cal.
McMahon, Thos. D., Archt., G. N., St. Paul, Minn.
May, Frank, For. B. & B., Mo. Pac., Charleston, Mo.
Moore, C. J., Mast. Carp., St. L. S. W., Pine Bluff, Ark.
Moreau, C. L., Gen. For., B. & A., Springfield, Mass.
Morin, T., Br. For., B. & A., Pittsfield, Mass.
O'Connell, J., Ptr. For., B. & A., Pittsfield, Mass.
Oetzman, E., Gen. For. W. S., A. T. & S. F., Fresno, Cal.
Paul, C. E., Prof. Mechanics, Armour Inst. Technology, Chicago.
Porter, G. F., Engr. Const., St. L. Br. Co., Montreal, Que.
Porter, J. W., Ch. Engr., H. B. Ry., The Pas, Manitoba, Can.
Purdy, G. A., Supv. B. & B., M. K. & T., Denison, Tex.
Rehmert, D. L., Mast. Carp., P. C. C. & St. L., Bradford, Ohio.
Reynolds, J. W., Carp. For., O. S. L., Pocatello, Idaho.
Roberts, A. C., Supv. B. & B., Mo. Pac., Monroe, La.
Sayles, H. H., For. B. & B., S. L. & S. F., Cape Girardeau, Mo.
Shobert, Fred, For. B. & B., Sou. Pac., Bakersfield, Cal.
Soothill, F. H. Bldg. Supt., Ill. Cent., Chicago, Ill.
Strate, T. H., Val. Engr., C. M. & St. P., Chicago, Ill.
Sturdevant, A. H., Mast. Carp., C. R. I. & P., El Reno, Okla.
Sughrue, T. G., Supv. B. & B., B. & M., Nashua, N. H.
Tamplin, J. F. Supv. B. & B., C. of Ga., Macon, Ga.
Walker, Fred, For. B. & B., O. S. L., Wellsville, Utah.
Webster, E. R., Asst. Engr., C. M. & St. P., Marion, Iowa.
Welch, W. F., Asst. Br. For., B. & A., Pittsfield, Mass.
Whitlock, L. M., Asst. For. B. & B., Mo. Pac., McGehee, Ark.

The secretary was authorized to cast a ballot electing the 48 applicants to membership.

REPORT OF THE EXECUTIVE COMMITTEE

One meeting of the executive committee was held during the year.

Congress Hotel, Chicago, March 20, 1918.

The meeting was called to order by the president, S. C. Tanner, with the following executive members present: S. C. Tanner, Lee Jutton, C. R. Knowles, Arthur Ridgway, F. E. Weise, J. P. Wood, W.

F. Strouse, J. S. Robinson, J. H. Johnston and C. A. Lichty. Past presidents in attendance were, A. S. Markley, J. H. Markley, J. N. Penwell, A. Montzheimer, L. D. Hadwen, and C. A. Lichty. Other members present were, R. C. Sattley, W. O. Eggleston, J. D. Black, E. T. Howson, J. Dupree, and B. R. Kulp.

The question was brought up as to the advisability of changing the location of the 1918 convention from New York City to some more central point as it was thought by many that it would not be wise under the existing conditions to hold the meeting in New York City. A number of other cities were considered, among the most prominent being Cincinnati, Chicago and St. Louis. After considerable discussion it was decided to hold the convention in Chicago.

The president appointed Messrs. Knowles, Jutton and Weise a committee on arrangements for the next convention.

No further business appearing the meeting was adjourned.

C. A. Lichty,
Secretary.

The President:—We will now have reports from the other standing committees.

REPORT OF COMMITTEE ON RELIEF

Joliet, Ill., Oct. 14, 1918.

To the Members of the American Railway Bridge and Building Association:

The committee on relief has received no requests for assistance during the year. It is indeed a pleasure to make a report of this character and indicates that our members are in very satisfactory circumstances.

Respectfully submitted,
Arthur Montzheimer,
Committee.

REPORT OF THE OBITUARY COMMITTEE

Salem, Mass., Oct. 12, 1918.

To the Members of the Association:

God in his divine wisdom, has seen fit to remove from our active membership and transfer to that greater membership the following: T. H. Bridges, McGehee, Ark., W. S. Danes, Peru, Ind., C. W. Lamb, Pine Bluff, Ark., W. R. Lanning, St. Maries, Idaho, E. S. Meloy, Chicago, J. C. Nelson, Norfolk, Va., S. J. Powell, Ogden, Utah, C. A. Redinger, Selma, N. C., A. P. Rice, Columbia, S. C., R. E. Todd, Madison, Wis., and D. C. Zook, Ft. Wayne, Ind.

Be it resolved that we hereby express our sense of bereavement and loss, that a copy of this resolution be spread upon our records and also sent to the families of our departed brothers with assurance of our grief and sympathy.

Respectfully submitted,
B. F. Pickering,
Committee.

The report of the committee was adopted.

Letters and telegrams were read from a considerable number of members who were unable to be present, among them being past presidents, Pickering, Andrews, Rear, Killam and Smith.

The President:—This completes the preliminary business. We will now take up one of the subjects for report and discussion before the noon hour. We will first take up the report on

Repairing and Strengthening Old Masonry. As the chairman, Mr. Strouse, is not present we will ask the secretary to read the report. (See report and discussion.)

A representative from the Liberty Loan committee gave a "four minute talk" on the Fourth Liberty loan after which the meeting was adjourned until 2 p. m.

AFTERNOON SESSION

Tuesday, October 15, 1918.

The meeting was called to order by the president at 2:15 p. m. The discussion on the report of the committee on Repairing and Strengthening Old Masonry was continued for a short time.

The president then called on E. T. Howson to introduce C. A. Morse, who read a paper entitled, "What is Essential Work?"

E. T. Howson:—When the railroads passed under Government control on January 1st all of the problems incident to their operations were transferred into the hands of the Government. Bridge and building men automatically came under the jurisdiction of the Government. The railway administration has had to build up a new organization. One of the most important branches is naturally that for the maintenance of existing properties.

About two months ago a man from Chicago, known personally to a considerable number of men in this Association, and known by reputation to all of them, was appointed Assistant Director of Maintenance in charge of maintenance work on all the railroads under Government control. Mr. Morse, who was chosen for that work and who is going to speak to us now on Essential Work, was at that time chief engineer of the Rock Island System and formerly of the Sante Fe System. He has spent his entire active life in railroad work. Mr. Morse is particularly fitted for this position in the federal Maintenance of Way organization because he has so long been an active student of maintenance problems. He is now president of the American Railway Engineering Association.

When Mr. Morse was asked to speak before this Association the suggestion was made that one of the most acute problems confronting bridge and building men is to determine what is essential work, and Mr. Morse has consented to speak for us on that topic.

Mr. Morse:—I have written out what I have to say, know-

ing that I think better sitting down than I do standing up, but before reading what I have prepared I want to give you a little idea of a few things I have picked up in Washington that possibly have some bearing on what I said in the paper.

We all know about the shortage of labor. The shortage of material is greater even than I realized until I went there and got into the game. On rail, for instance, we are going to be in the neighborhood of half a million tons short for 1918 and there are many railroads that didn't order, being afraid of the price which ranges from $30 to $35 and up to $40. For 1919 there is every prospect of our being a million tons short, or of our getting only about two-thirds of the rail next year that we require.

On ties, they figure that the requirements this year were 126 million. The Purchasing committee which handles that say that the best we can do is to get 70 per cent of this number so that we will also be very short of ties.

I don't know just where we stand on material for bridges and buildings but I have been connected with the War Department in connection with the Division of Construction since I have been in Washington and since I have found out what they are doing I am wondering how we get any material. They have an organization at the present time in which they have 323 construction quartermasters, practically engineers. The head of the division told me that when they completed these 323 projects they would have spent a billion dollars on buildings and construction in connection with them.

In addition to this the ship-building operations are requiring an immense amount of work in housing. I was in Newport News the other day and saw a group of buildings they are putting up to take care of their employes. They are building similar groups of buildings all over the country where they are doing shipbuilding.

The President:—Mr. Morse has come from Washington to read this paper to us. I will be glad to entertain a motion that we show our appreciation by giving him a rising vote of thanks.

A rising vote of thanks was then tendered to Mr. Morse.

The President:—We were to have some remarks by Dr. von Schrenk on the Material Problem on Thursday but as he will not be able to be with us on that day we will ask him to discuss this subject now.

REMARKS BY H. VON SCHRENK

H. von Schrenk:—I have failed to prepare a formal written report, but I will be very glad to say a few words about the material situation. All I can possibly say at this time is to echo in very strong words the general remarks which Mr. Morse has just made in regard to the economical use of material.

I know that for many years all of us have wanted the best and many have been the requisitions for the highest classes of materials when others would have been sufficient. The time is upon us now when we have little choice. We are confronted with the situation that lumber, steel and other materials simply are not available.

The bridge man is facing the problem of maintaining structures without materials and labor—in other words he must depend on his wits. I want to speak briefly about the practical question, "How can we best use our wits in meeting the present situation?"

Last year we maintained a rather optimistic viewpoint in regard to the materials necessary in the construction of bridges, but with the demand from the various departments of war, the demands on the part of the large shipbuilding organizations, the poor railroad man is left with practically no material. Yellow pine timber is practically unknown. Douglas fir, of which we used to hear a good deal, cannot be counted on with any degree of regularity. Still we can't run trains on thin air.

Here is the first suggestion: We can repair those parts of a bridge that are in halfway condition so that they can still serve. Last year I suggested the use of small boxes with rock salt immediately under the caps of pile bridges. There are many pile bridges today which we would renew under ordinary circumstances —that is, the piles have probably decayed far enough to remove. Up to the present time we cannot get the piles or the preservatives to treat them. Many of these piles which under ordinary circumstances we would remove, we ought not to remove now if we can in any way secure a year or two additional service from them. I have yet to find any scheme which does the work for so low a cost as those boxes under the caps filled with rock salt, because they are self-feeding. They can do very little harm and may do a great deal of good.

The last time that I looked at spans built in Southern Louisiana five years ago they looked like alabaster; I couldn't drive a knife in them and they have every appearance of lasting two or

three times as long. When it comes to stringers and caps, many a stringer is defective in certain spots. This is a time for us all to consider board planing very seriously—even stringers, if they have to be re-sawed for the purpose of developing the use of such pieces as are good in the form of laminated construction. We did that a few years ago. Think how many pieces can be combined in one and made to serve in a manner fully as serviceable as if one had used a new stick of wood.

To use untreated material may seem like taking a step backward but that is absolutely essential today. We have two preservatives, creosote oil and zinc chloride. A large percentage of creosote oil comes from Europe. We have available less than approximately fifty million gallons of creosote oil. This must supply the army, navy and shipbuilding board and the railroads. The War Industries board has gotten up a very workable scheme of relative necessities for these materials. Of course the railroads generally come last in this list.

Creosote oil will be available to some extent. We have just been advised that they are going to distribute a supply of oil from Washington for such railroad jobs as may be proven necessary. We have to build our structures without that oil wherever we can. For instance for stringers, guard rails, etc., use as much good heart material as is possible so as to avoid the necessity for treatment but on the other hand where it is essential that you should have some oil you should not have any hesitation in asking for it with a reasonable expectation of getting it.

Zinc chloride, which we hear so much of as taking the place of oil, is not available either. In the manufacture of zinc chloride we have to have sulphuric acid, an essential in the manufacture of munitions and an important chemical needed by the army abroad, so no faith should be pinned on the supply of zinc chloride.

At a meeting held to discuss the use of preservatives for wood we all came to the conclusion that it is necessary at this time to close our eyes to many of the high standards we would recommend in ordinary times, and that we should now favor the use of methods and materials if they will serve even for a comparatively short period.

A further point which I believe should be brought out at this time is this: We ought to use every bit of material that can be obtained as close at home as possible. We ought to avoid to the very utmost the necessity of shipping material any greater distances than

possible. We have been accustomed to using white oak and white pine in the past, considering them essential and the only kinds of wood we could use. The United States is blessed with a great many classes of timber, a number of which we didn't think were fit for anything. A few years ago we thought that a stick of beechwood placed in a station platform would be a half mile away by the time you were once around the station. That is practically true but let me say this to you—"necessity is the mother of invention" and we are confronted at the present time with a condition of not what we would like to do but what we have to do. It is amazing, if one will open his eyes, to find the species of wood immediately available which one can well afford to take a chance on today.

Track men have become aware of this condition more quickly than bridge men. For instance, we are using sycamore ties that we rejected 12 months ago. Our principal endeavor should now be to ascertain the materials which are available under our local conditions.

In that connection I am going to suggest that some one of your committees investigate and tabulate information as to the relative stresses which it would be safe to use with the various hardwoods that are available. You ought to have information available in your Association which would tell at a glance what factors of safety it would be possible to attain from different woods which are native to you. Take red oak, for instance, which we have considered unfit for use because of short life. Its use would remove the necessity for many sticks of beech, white oak and other timbers. It seems to me that this information should be spread broadcast.

Another point that I have noticed recently in making inspections which we want to pay increased attention to is the question of fire. As our bridges grow older the danger from grass fires at their ends increases and bridges that we considered fire safe a few years ago are not now so considered.

Salt boxes such as I spoke of will be of much advantage in putting out sparks. By their use a great many piles could be saved which at the present time are rapidly approaching decay. Menacing conditions of this kind can very frequently be remedied by covering the timbers with small pieces of metal or by the application of temporary fire protective paints.

The upshot of this rather rambling discussion is that we will have to broaden our viewpoint as to the fitness of the materials

which we have, forget for the time being that we cannot do things unless we have the best, forget also for the time being that we have to use only specific classes of material and do the best we can with what we have with the anticipation that we are not going to get any more. Above all we must use our wits in making what little we can get give us the very utmost length of service.

The President:—Dr. von Schrenk's discussion deals mostly with the different woods we use. I believe Mr. Howson can say something to us on the metal situation.

Mr. Howson:—I have nothing of my own to offer but have some correspondence that came to me for presentation. We had hoped to have Mr. Parker or Mr. Powell of the Priorities division of the War Industries Board here to discuss the metal situation. They found that they could not be here so Mr. Powell gave me some data which he thought might be of value to our members.

(As he was unable to be present at the convention T. C. Powell, a member of the Priorities Committee of the War Industries Board sent a written communication describing the work of this organization in conserving the steel output of the country for the most essential needs. Abstracts from Mr. Powell's letter and from circulars of the War Industries Board will be found among the reports in this issue.

The President:—We have a letter on the same subject, the conservation of metal, written by George W. Andrews. The Secretary will read the letter.

(See letter elsewhere.)

C. R. Knowles (chairman) was called upon to read the report on Water Supply, (a) Sources of Supply, (b) Wooden Tanks. (See reports and discussion.)

The remainder of the afternoon was consumed in the discussion on wooden tanks. The meeting adjourned at 5:30 to convene at 9:30 a. m. Wednesday.

MORNING SESSION

Wednesday, Oct. 16, 1918.

The meeting was called to order by President S. C. Tanner at 10:00 o'clock.

The President:—The first paper to be presented this morning will be "Carrying Bridges Over" by C. F. Loweth, chief engineer of the Chicago Milwaukee and St. Paul Railway. Mr. Loweth found it necessary to leave for Seattle yesterday morning with the Fed-

eral manager and wanted me to express his regrets at his not being able to be present. He has asked Mr. Stevens to read his paper.

(See paper and discussion.)

The President:—We will not discuss this paper at the present time as we are honored with the presence of Mr. R. H. Aishton, regional director of the Northwestern region, who will tell us how bridge and building men can help win the war.

REMARKS BY MR. R. H. AISHTON

R. H. Aishton:—Mr. President and Members: I am very glad to come over here and meet with you. It is really surprising to me that, with the tremendous epidemic of influenza sweeping over the country, you have as large a representation as you have here today. I can well imagine that many of you would rather be somewhere else.

What can you do to win the war? I don't know (and I say it truthfully) of any class of men unless it be the section men that has so wholly, so thoroughly and so well performed its work as the bridge and building men. There never has been a question about their giving 100 per cent service. It would be folly for me to offer any suggestions to you as to what you could do to help win the war. You are helping. You're doing everything in your power. I know it because I know the railroad men all over this country are doing the same thing. There isn't any question any more when anything arises as to whether we will do it or whether we won't. What goes through every man's mind? Will it help the President; will it help the soldiers in France; will it help win the war? That's the thing that goes through their minds. It isn't a question of personal discomfort, it isn't a question of 44 hr. or 60 hr. work; it isn't a question whether we will ride or not. What is the final analysis that goes through every man's mind? The first thing he thinks is that it must help win the war. How could I offer any specific suggestion as to what you could do to win the war?

This meeting today is responsible for that thought that is in every man's mind. You call it a War Council. What are you counseling about? You are counseling how to meet the conditions that have been brought about by this war. I notice in your program, "Carrying Over Bridges" by Mr. Loweth. What could I tell you about carrying over bridges? You folks know what to do; you know you are short of labor, you know you are short of material; you know there are conditions you never had to meet be-

fore,—and this discussion that you are having here is an indication of what is in your minds. You've got to do everything you can to carry over everything you can carefully, safely and efficiently, and do it with the things you have in hand. In other words, do more than you ever did in your lives with the material you have. That is your problem and you are working it out. We are all working it out.

You know the load these railroads are carrying. Very few people have any real conception of it. We thought we were busy two years ago when the war first started. It can't compare with the transportation being handled today. Take the matter of moving troops. Do you know that during the month of August 400,000 soldiers were delivered at embarkation points and these soldiers were, some of them, moved from the Pacific to the Atlantic Coast?

The Great Northern Railroad handled 19 passenger trains in one day. Every soldier had a bed, a bath and three meals every day through the entire trip. I mention the Great Northern because I happen to know about that. Do you know that for months the transportation lines have not only moved those soldiers but that for months seven soldiers have stepped off the gangplank every minute, day and night? Just think what that means! A steady stream day and night! They have all had to be transported. It takes as much transportation here to transport them as it does on the boats. When you think of that you get some idea of what the transportation lines have to carry.

They couldn't carry it for one minute unless you men that are sitting here and have control of the forces that bring about the conditions that make it safe to move those trains,—did not have in your minds continually the question "What can I do?"

I could go through your entire program in like manner. Here's a report of a committee on Shipping Company Material Economically. Any of the Northwestern employes can tell you that I have burned their hides more than enough on that kind of thing in years gone by. (Applause.)

You can help a great deal. Every car that is moved over these railroads is moved with terrific effort nowadays. You can make up your minds that every car that a bridge man moves with a stick of timber, a handcar or something of that kind is taking the place of a car that ought to be going toward France and Germany with something that is absolutely needed on that battlefront. Get that into your heads. Whenever you see a car moving over a rail-

road unnecessarily you can make up your mind that the fellow shipping that is a slacker. He is working for the Kaiser just as directly as Bernstorff was. I am glad that subject, Shipping Material Economically, was placed on your program and I hope that when you go back you will spread that thought among all the men.

When we think of what is going on over there in France I don't see how anybody can hold back, no matter whether it is money, time, effort or anything else. The least every man can do is to give everything he's got to clean this thing up. You know that the great American and soldier, Gen. John Pershing, stood before the tomb of Lafayette a few months ago and as he laid a wreath on his tomb he said, "Lafayette, we are here." He didn't mean he was there with 100,000 soldiers. He meant that the American nation was there with every cent it had, with every ounce of energy and blood it had. Haven't we got to make good on that? Your boy is there, my boy is there. Wouldn't we be lagging in our duty if we didn't give everything we have? Just think of that a little. That doesn't mean one thing or another,—it means everything. I made as heavy a subscription to the Liberty Loan as I thought I could; I went in debt for it, yet before night I intend going some more. I believe it is the duty of every American citizen to go clean to his neck. I believe he ought to go in debt for it and buy additional Liberty bonds. That's one way you can help.

Mr. Weise:—I think we ought to show our appreciation by giving a rising vote of thanks to Mr. Aishton.

A rising vote of thanks was tendered to Mr. Aishton.

Mr. Aishton:—I appreciate that very much, Mr. President.

The President:—We will now take up the discussion of Mr. Loweth's paper,—Carrying Over Bridges. (See discussion.)

The next subject to be taken up is that of Shipping Company Materials Economically of which Mr. Brantner is chairman. As Mr. Brantner was unable to attend the convention I will ask the secretary to read the report. (See report and discussion.)

The remainder of the morning was taken up in the discussion of the latter report.

The meeting adjourned at noon until 2 o'clock.

AFTERNOON SESSION

The meeting was called to order by the president at 2 p. m. Mr. Tom Lehon stated that he had the pleasure of meeting Major

C. E. Smith (president 1917) a few days previously at Washington where he is in the service of the Government in planning camps and cantonments. Mr. Smith sent greetings to the members in convention.

The President:—We are honored in having with us W. H. Finley, president of the Chicago & North Western, one of our members, who will talk to us for a few minutes.

REMARKS BY MR. W. H. FINLEY

W. H. Finley:—I have always taken a lively interest in this Association, and I only regret that I have not been able to attend all of its conventions. The few that I have attended, I have enjoyed very much indeed. I do not believe that there is another association of this kind in the United States that brings together the practical and the theoretical men as this does. I say that advisedly. I know that a lot of us are theoretical and a lot of us are practical. I do not know of any organization of railroad men that really means more to the railroads than this Association. I still have a very distinct recollection of the time it was first formed and the criticism, the controversy and the discussion as to the necessity for such an organization. The great difficulty and trouble in forming any sort of an organization is the cry that goes up, "We have organizations enough, why create another one?"

I have looked forward with a great deal of pleasure to the reports of this Association's conventions because I knew that everything that was published in your proceedings was the result of an intimate knowledge of the subjects that you reported upon. I do not believe that, in all of the various organizations connected with railroads, any association has done more or given more toward the practical advancement of railroading than this association. (Applause.)

I also know that the bridge and building men of the railroads have been a quiet, uncomplaining set. They have met their problems on all occasions and have carried them out in storm and stress; they have worked uncomplainingly in all kinds of inclement weather; they never asked any odds and they carried out the tasks that were set before them. I believe there is no set of workmen, with probably one exception, on the railroads of the United States today that has received less recognition for the services they have rendered the railroads than the bridge and building forces.

I will always hold in grateful remembrance my early association with the superintendents of bridges and buildings of the only two roads that I have ever worked for. I have been out with them on all sorts of trips and on all occasions. We never asked any odds of each other. We always met the issue. Today when I look back in retrospection over somewhat more than a quarter of a century of engineering and railroad experience, I always hold in warm remembrance my association with the bridge and building department employes of the railroads that I have been connected with. As I said before, they have been an uncomplaining lot, they have done their work, they have asked no odds and I hope that they will now in the immediate future get their reward.

The conditions confronting the bridge man in an emergency can only be compared in a modified degree with what our soldiers, our bridge builders, are going through over in Europe today. I have followed this, as all of you have, with a great deal of interest as far as bridge building was concerned. One of the first things in this war that struck me with a great deal of force was the description written by a newspaper writer of the entry of the German army into Belgium. He described the German general riding over into Belgium and asking for the surrender of the forts at Liege. Being refused he rode back, and the bridge was immediately blown up by the Belgians.

The German pioneers were the bridge builders and engineers who were sent forward to replace that bridge. Think of it for a moment! They were not excited by the question of war or combat. They were simply workmen trying to build a temporary bridge across the river while the Belgians were taking shots at them. That requires a higher degree of courage in my opinion than it does to go over the top in the front trench when you have all that inspiration of combat and fight in you. The same thing was done by the Americans when they bridged the Marne after the Germans had succeeded in crossing it and were driven back. They bridged the Marne under the fire of the Germans. They bridged it standing waist high—shoulder high—in water, without any possible opportunity to do anything but the work they were doing. They were not fighting. If you can stop for a moment and visualize that condition on the Marne, of those engineers being there with one purpose, to put a bridge across so that the American forces could cross. They did it although the

German sharpshooters and machine guns were sweeping the stream from one side to the other. We are giving them every credit.

When I was quite a young man I was living within probably two or three blocks of where the Baltimore & Ohio line from Baltimore to Philadelphia crosses the Brandywine river. Being a young man and just starting in on my life's work I paid more attention probably to the construction of that bridge and it made a greater impression than later work has made upon my mind. The track was about 115 ft. above low water mark and the bridge was an ordinary pin-connected deck truss. They put up false work that I think the majority of you would laugh at today.

The timber was mortised and tenoned as if it was going to stay there during the life of the bridge. They were just driving the last pin, working at night, when a freshet came down the river, took out their false work and dropped the bridge into the roaring torrent.

Of course I got over there very quickly the next morning. I was interested, and anxious. When I arrived at the scene of the accident, I saw an individual out on the middle of a foot bridge directing the operations of recovering the wreckage of the bridge. I worked my way out to him and asked him some questions. He looked at me in a sort of pitying way and said: "Say, are you an engineer?" I said yes. I was afraid I wouldn't have time to say it. He said, "Forget it,' (laughter) and he went on, in the words of Bret Harte, in language that was free, forceful and impolite, directing the forces in recovering the bridge.

To give you an idea of how the ordinary layman looks upon some of these things connected with bridge building, I am going to tell you a story. A very eminent engineer of this country, Dr. Waddell of Kansas City, wrote a book about bridges and bridge specifications years ago. He gave it the Latin name of de Pontibus. It contains valuable information as to bridge construction, bridge design and bridge specifications. Some years ago the Northwestern was building a line in Wisconsin and I happened to be out on the work when I received a telegram to go to Sheboygan and find a letter that would be there for me. I went there and found the letter which stated that the bridge over Pennsylvania Avenue, I think, had been closed to traffic. It seriously interfered with access to the Northwestern freight house and station and I was instructed to see the city engineer

and see if we could not arrive at some way of fixing the bridge up so that it could be put in service. When I went around to the city engineer's office the first man I saw in there was an engineer from a competing company. I said to him, "You know what we are here for, let's go down and look at that bridge." He said, "All right." It was a drawbridge with a couple of fixed spans across the Sheboygan river. I was quite surprised to find that he was agreeing with me on almost every point that I raised about the bridge and its condition and I was at a loss to just understand the situation. Of course, the street car company was anxious to run cars across. I induced the street car company to run some of its heavy cars down there and made some fancy tests as to emergency stops, etc. After we got through with it, we made some rough figures as to the maximum stresses in the drawbridge.

I said, "Gentlemen, this bridge is all right. No reason to put it out of service. You need not put those barriers back."

The members of the board of public works who were with us were all German excepting one fellow named Kelley and I had a sneaking suspicion that he was not German. (Laughter.) They said, "That is all right but we will not put that bridge in service unless you give us a written opinion over your signature that that bridge is safe." I said, "I will be glad to do that."

We went back to the city engineer's office and I wrote out an opinion regarding the bridge and its safety for the traffic passing over it, signed it and handed it to the chairman of the board. Kelley said, "Would you like to see the report of our consulting engineers on this bridge?" Well, I was absolutely taken back. It had never entered my mind that they had secured the services of a consulting engineer to investigate the safety of the bridge. I said I would like to see it and he handed it to me.

The first thought that occurred to me as an engineer was, "How am I going to preserve the ethics of the profession? Here, evidently, is a consulting engineer who has condemned this bridge and I have said it is all right. How in the world am I going to square this thing and get an even break and not discredit the profession?"

I started to read his report in which he said that his firm had a great many years of experience in designing, examining and repairing bridges and that they never condemned a bridge unless it was beyond all hope. After a careful examination of the

bridge and an analysis of the stresses he found that, according to the loading of de Pontibus this bridge was over-stressed and he gave the over-stressage, running up to nearly 300 per cent.

Just then a happy idea struck me. I thought I saw a way of saving the ethics of the profession without discrediting my fellow engineer so I turned to the board of public works and I said, "Gentlemen, I think your consulting engineer is all right. This bridge is not strong enough to carry de Pontibus. Do you run de Pontibus over the bridge?" One gentleman said, "No, sir, I never saw von on the streets of Sheboygan."

I said, "The bridge is safe as long as you don't run de Pontibus over it. Are you willing to put up a sign that this bridge is safe for everything but de Pontibus?" They were quite willing to do it and started out to prepare a sign that de Pontibus couldn't run over the bridge. There isn't any doubt that the majority of the people up there today think that de Pontibus is some sort of a steam road roller.

That was the one and only occasion in my life when I was able, by a method of that sort, to maintain the ethics of the profession.

This war and the times we are going through are epochal. Nothing like it has ever happened in the history of the human race. The conditions that we must meet, the questions that we must solve are questions that were never presented before in the history of our race. They are broad, they are far-reaching. In my opinion there is going to be an entire change of conditions and social usages that have existed in the past. It is up to all of us to give these problems the broadest, most careful consideration, to give them all the thought we can.

One thing has distinguished the United States in comparison with any other Government or any other country in the world and that has been its individualism—the fact that we could develop along our own lines. You might differ with me; we might not agree, but you had the right to go along your own lines and I along my lines and reach the solution of the question as we thought it should be reached. That has, in my mind, been the biggest thing that has put the United States today where it is. It is so different, gentlemen, from what has been the custom in Germany. There one pattern was held out to all the people. They lived up and grew up simply to that pattern. They could not go beyond it. They could not deviate from it. You see the result.

Here, in the United States we have counted on individualism, individual effort and individual initiative. It is this that has made the United States what it is today, a country that in this war has made an effort that was not dreamed of by any country or government in the world. We were smiled at and laughed at by even our friends; that this peace-loving nation, this nation of commercialism, of "dollar chasers," as they chose to call us, could never meet this supreme effort if it was put upon us and yet in less than one year and a half our accomplishments have been far beyond any of the military nations of Europe. It is something that is going to stand in history as one of the most remarkable things that ever took place in the history of the human race—the warlike effort that the United States has put forward. We know, and always knew, that we were not a warlike nation. We didn't pride ourselves on our military strength but almost everything that is used in Europe in this war today is an American invention. The machine gun that the German army today is relying upon more than any other arm is an American invention. The only other thing that is overcoming it, the British tank, is an American invention. The flying machines are an American invention. The submarine is an American invention. Yet we are not a warlike nation.

I never realized fully what our individualism meant until I read Dentist Davis' articles on his associations with the Kaiser. He related one incident that to me was very illuminating. It was this: After an exhibition of the Wright flying machines in Germany some years ago the Kaiser turned to Davis and said: "Davis, I envy your country its inventive genius." He did not realize, and probably does not today, that that inventive genius came from the kind of government we have, the kind of government that did not interfere with individuals—that did not set up that the State was everything and the individual nothing.

It is an easy thing to change our ideas, to change our form of government even under military pressure. I hope and trust that every man within hearing of my voice will still believe in, and will still lend his efforts and his best endeavors to preserve the individualism of the American citizen. Thank you. (Applause.)

The President:—I would like to ask the gentlemen to indicate by a rising vote of thanks their appreciation and thanks for Mr. Finley's remarks.

(Audiences rises and applauds.)

The President called on F. E. Weise to read his report on Labor Saving Devices. (See report and discussion.)

REPORT OF THE AUDITING COMMITTEE

Chicago, Oct. 16, 1918.

To the Officers and Members of the American Railway Bridge and Building Association:

We have examined the books and the accounts of the secretary-treasurer and find them to be correct as given in the report.

J. S. Robinson,
R. C. Sattley,
M. Riney,
Committee.

The secretary stated that reports had not been received on the subjects of "Concrete," and "Painting Metal Structures."

(A paper on "Factory-Made Reinforced-Concrete," by Charles Gilman, bearing particularly on this subject, is reprinted elsewhere in this volume.)

H. A. Gerst read the report of the committee on Bridge Floors and Guards. (See report and discussion.)

J. P. Wood read the report on the subject of Small Versus Large Gangs for Maintenance Work. (See report and discussion.)

The committee reports being completed a vote was taken at 3:30 to decide if the remaining business should be completed during this session or carried over until Thursday morning. The vote was unanimous that the work should be completed Wednesday afternoon and the convention brought to a close.

REPORT OF COMMITTEE ON NOMINATIONS

Chicago, Oct. 16, 1918.

The Committee on Nominations recommends the advancement of the present officers and executive members as has been the custom in the past. E. T. Howson has been recommended for election to fill the vacancy on the executive committee caused by the death of D. C. Zook, and the name of C. W. Wright as the sixth member of said committee.

R. H. Reid,
J. P. Canty,
J. B. Sheldon,
Committee.

ELECTION OF OFFICERS

W. M. Camp moved that the rules be suspended and that A. H. King cast the ballot for the convention, electing the officers and executive members recommended in the committee's report. The motion was carried which resulted in the election of the following:

Officers: Lee Jutton, president; F. E. Weise, first vice president; W. F. Strouse, second vice president; C. R. Knowles, third vice president; Arthur Ridgway, fourth vice president; C. A. Lichty, secretary-treasurer. Executive Members: J. S. Robinson, J. P. Wood, A. B. McVay, J. H. Johnston, E. T. Howson and C. W. Wright.

President Tanner:—Before retiring from the office of president, which I have had the honor to hold during the historical year of 1918 I wish to thank each and all of you for your loyal support, and especially the chairmen and the members of the various committees. The fiscal year which is just closing has been a memorable one. We have had many perplexing problems to contend with. There were times when we did not know whether or not we would be permitted to hold a convention and it became necessary to take the matter up with the Railroad Administration, when it was decided that we could continue in the regular way. Then about the time we were preparing to go to the convention the terrible epidemic of influenza was prevalent and this has given us a noticeable setback for attendance. Many of our members had all arrangements made to be here but were finally detained on account of conditions growing out of the epidemic. Nevertheless, we have had a successful meeting and I wish to thank you all for your faithfulness.

Mr. Jutton, will you please come forward? You have been elected president of this association which is the highest honor it can bestow upon any of its members. In presenting this gavel I can assure you that there are no "slackers" in this organization, and I bespeak for you the loyal support of its members that they have given their officers in the past which is a record that any organization can be proud of.

President Jutton:—Mr. Tanner and Fellow Members: I want to say that I am truly grateful for the honor you have accorded me. I realize fully that with this office goes the responsibility of keeping our association in a healthy condition and I will certainly give my best efforts. I must also say that in accomplishing the best ends it will be necessary for me to have the support of all the members and I only ask that I be given the support you have given our presidents in the past. It will be necessary for our committees to work faithfully to keep up the reputation they have established in former years. I thank you, gentlemen.

The other officers were duly installed.

The President:—We will now decide where the next convention will be held. Nominations are in order.

A. H. King nominated New York City, stating that the executive committee had the right to change the location if for any reason it became necessary.

J. Dupree nominated Washington, D. C., but the nomination

was withdrawn after remarks made by President Tanner wherein he stated that the city of Washington was a very poor place to meet as the hotels were very much crowded and likely would be for some time to come.

W. M. Camp nominated Philadelphia, followed by St. Paul, by E. T. Howson; F. C. Baluss placed in nomination Atlanta, R. H. Reid, Cleveland, and L. Jutton, Indianapolis.

The ballot resulted in the selection of Cleveland, the vote being made unanimous.

REPORT OF COMMITTEE ON SUBJECTS

Chicago, Oct. 15, 1918.

To the Chairman and Members:—

The committee on subjects submits the following list, which is to be completed at the March meeting by adding new subjects and inviting various members and others to submit papers, as has been the custom in late years:

Methods and Equipment Used in Renewing Timber Bridges.
Inspection and Repairs of Roofs.
Methods of Bridge Inspection Under Present Conditions.
Economical Use and Storage of Fuel at Railway Pumping Stations.
Painting Metal Railroad Structures.
Tools.
Paper,—Railway Fire Equipment.

Respectfully submitted,
F. E. Weise,
E. T. Howson,
C. E. Smith,
Committee.

The secretary recommended the names of the following members for life membership: Ed Gagnon, retired supervisor of bridges and buildings on the Minneapolis & St. Louis; Amos H. Beard, retired master carpenter, Philadelphia & Reading, and Albert Mountfort, pensioned division foreman of bridges and buildings, Boston & Maine.

The above named members were elected to life membership.

C. R. Knowles made a motion that if the Association had any money to spare it might be invested in Liberty bonds. It was voted to leave this to the discretion of the executive committee.

The Secretary:—I wish to state that in accordance with the instructions which I received at the last convention I wrote to Phelps Johnson, president of the St. Lawrence Bridge Co., at Montreal, conveying to him and his Company the congratulations of the Association upon the successful completion of the great Quebec bridge.

The following communication was received from Mr. Johnson in reply:

C. A. Lichty, Secretary,
My Dear Mr. Lichty:—

I have been absent from Montreal for a week or so and upon my return I find awaiting me your letter conveying to me and my Company the congratulations of the Association upon the successful completion of the Quebec bridge. I am indeed very pleased to have your communication for I appreciate that the congratulations come from a body of men who really know what was involved in the work we have done and who are best qualified to pass judgment upon it.

With best wishes for yourself and the Association.

Yours very truly,
(Signed) Phelps Johnson,
Pres. St. Lawrence Bridge Co., Ltd.

PATTERSON MEMORIAL

W. M. Camp reported on the Patterson Memorial as follows:

The proceedings of the special memorial meeting held at last year's convention were edited and published in a special volume and these were sent to the members and the usual depositories where our proceedings are kept.

A subscription was taken for a memorial block and tablet to be placed on the burial lot. That subscription, together with subsequent contributions which were sent in during the winter, now amounts to $210.75 which is in the hands of the treasurer. A canvass of the art market developed that it would be unwise to carry out the plan at present on account of war conditions. It is my understanding that this matter was to be deferred until conditions are more favorable.

The President:—If there are no objections the committee will be continued until its work can be accomplished under more favorable conditions.

We will now have the report of the committee on resolutions.

REPORT OF THE COMMITTEE ON RESOLUTIONS

Chicago, Oct. 16, 1918.

Resolved:—That the thanks of the Association be extended to the following individuals and corporations:

To the United States Railroad Administration for sanctioning the holding of this meeting:

To Messrs. R. H. Aishton, C. A. Morse, W. H. Finley and C. F. Loweth for their interesting and instructive papers and addresses:

To George F. Porter, for the interesting photographic views, moving pictures and address on the erection of the Quebec bridge:

To C. K. Melton for presenting slides, moving pictures and lecture on Mississippi river flood protection:

To the Pullman Company for extending half rates and to the

various railroads for the transportation of our members and their families to and from the convention:

To the New York Central for transportation to and from the Universal Cement Company's plant at Buffington, Ind.:

To the Universal Portland Cement Company for inviting our members to visit their plant and for the excellent lunch provided:

To the press and technical journals and their representatives in reporting the activities of the convention:

To the officers, chairmen and members of committees, who, under existing trying conditions, gave their time and efforts which resulted in the success of this convention:

Be it further resolved that these resolutions be spread on the minutes and the secretary instructed to forward copies to all parties interested.

Respectfully submitted,
F. E. Schall,
J. P. Wood,
P. J. O'Neill,
Committee.

The President:—This completes the business of the twenty-eighth annual convention and I wish to thank you all for the good attendance and close attention to business. Although the attendance has not been up to the average of recent years this has been on account of conditions resulting from the war and more so on account of the raging epidemic of Spanish influenza in all parts of the country which has kept many from attending who would otherwise have been here. Despite war conditions it appeared a short time ago that we might have a record attendance. The Federal managers of the railroads certainly did all they could to assist our members in getting here.

We will now adjourn to meet in Cleveland the third Tuesday in October, 1919, unless it is deemed wise by the executive committee to change the location of the convention.

C. A. Lichty,
Secretary.

Reported by Master Reporting Co., Chicago.

MEMOIR

JOHN C. NELSON

John C. Nelson, engineer maintenance of way of the Seaboard Air Line, died at Norfolk, Va., on October 6, following an attack of Spanish influenza. He was born at Belton, Texas, on November 3, 1862, and entered railway service with the Richmond & Mecklenburg Railroad, as a rodman on an engineering corps, in July, 1882. From February, 1883, to April of the same year he was a levelman with the Richmond & Danville Railway, from which time until February, 1884, he was resident engineer with the Richmond & Mecklenburg road. From the latter date until March, 1891, he was assistant engineer on the Cincinnati, New Orleans & Texas Pacific and from March, 1891, to May, he was resident engineer on the Louisville Southern. After three months' service with the Cincinnati, New Orleans & Texas Pacific as an assistant engineer he went with the Cleveland, Cincinnati, Chicago & St. Louis as engineer maintenance of way on the Cincinnati division, with headquarters at Springfield, Ohio. In September, 1899, he was appointed division engineer on the eastern division of the New York Central & Hudson River Railroad, with headquarters at New York, where he remained until 1902, when he returned to the Cincinnati, New Orleans & Texas Pacific as roadmaster. In 1907 he was appointed engineer maintenance of way of the Seaboard Air Line, which position he held until the time of his death.

Mr. Nelson was highly esteemed by his associates and his sudden death was a great shock to them. During the eleven years of his connection with the Seaboard Air Line Railway, he had impressed his personality upon his associates in a manner which will long be remembered.

He became a member of the American Railway Bridge and Building Association at Jacksonville, in 1909.

W. R. LANNING

Wm. R. Lanning was born near Ottumwa, Iowa, on June 25, 1869. He received his education in the public schools, leaving at the age of 15 to learn the carpenter trade. His first railroad experience was gained with the old Chicago, Ft. Madison & Des Moines Railroad; in March, 1893, he was employed by the Chicago, Milwaukee & St. Paul Railway as a carpenter. Shortly after this he left to work at his trade elsewhere and also took up contracting and building. In 1907 he again entered the service of the C. M. & St. P. Ry., being located at Pontis, South Dakota, where the construction of the Puget Sound line was under way. In 1907 he was made carpenter foreman and in August, 1908, he was promoted to the position of chief carpenter, which position he held until March, 1915, when he was obliged to take a leave of absence because of ill health. After a few months he again returned to service as chief carpenter at St. Maries, Idaho, in which position he remained until his death on Apr. 8, 1918.

Mr. Lanning was in poor health for the last few years of his life and his trouble was largely aggravated by exposure during washouts in the Bitter Root mountains near Avery, Idaho, during the latter part of 1917. He died at his home in Missoula, Mont., on April 8, 1918, leaving a wife and three sons, Russell, Burdette and Harold, the latter being a sergeant in the United States army. He was connected with the Christian church of Missoula, Mont., and also belonged to the Fraternal Brotherhood.

Mr. Lanning took a very active part in the work required by the railroad during the fires in the Bitter Root mountains in 1910, and fre-

quently referred to this period as being the most important in his railroad career. The following extract from an article published in Everybody's Magazine of December, 1910, indicates the active part which Mr. Lanning took in that event:

"On the day the fire became unmanageable there were no fewer than 1,000 people along the line of the C. M. & P. S. railroad in the 48 miles between Avery, Idaho, and Haugan, Montana. These were mainly railway employees, their wives and children, and refugees from the interior, although there were many tradespeople in the villages. Four work trains were busy on that stretch of track under the direction of C. H. Marshall and W. R. Lanning, superintendent and chief carpenter, respectively, of the Missoula division. A telephone message to Superintendent Marshall from the girl operator at Kyle, a small station, gave the first alarm of the approaching fire. While they were talking the wires went down.

"Marshall and Lanning at once ordered two of the trains to proceed along the line, picking up everybody. 'Don't pass anybody, no matter who it is, and put every living soul aboard, whether they want to go or not,' was the order given to the trainmen and a few American laborers who, the railroad officials knew from past experience, were the only men in the jumble of nationalities upon whom they could depend.

"Before the trains had gone far the fire was in sight. From mountain to mountain the flames leaped, with the speed of a fast train sowing brands upon the slopes to kindle slower, even more deadly fires. With the fire came the gale. Stones of a pound weight, gravel, dust, debris of the forest, were hurled before it, and soon clouds of smoke, fire-tainted, scorching, thicker than ever, completely obscured the sun.

"More than 400 people were herded into the cars east of the St. Paul Pass tunnel by Lanning and carried into the great tube, which is almost two miles long. There they remained in safety, suffering somewhat from smoke. Under the direction of Superintendent Marshall several hundred were taken out by the way of the east to Haugan. In another, and shorter tunnel, 200 people found refuge. They were pulled there on a train by Engineer Roberts, who ran a blazing bridge, over 700 ft. long and 100 ft. high, to put them there. When they reached the tunnel the fuel oil in the tank was frying.

"But that did not take care of the people. Scattered along the line between the great tunnel and Kyle, Idaho, were many whom it seemed impossible to save. The fire was pouring across the track, many bridges were going. 'We'll make a try for it, just the same,' said Lanning.

"An engineer and a fireman volunteered for the perilous venture, likewise a conductor on one of the work trains. With an engine and three cars they set out. It was apparent to all as they proceeded that they would never be able to return to the big tunnel. When the train reached the refugees huddled along the track, many of them had to be lifted in bodily, cutting from their backs rolls of blankets and any other inflammable material. Water in barrels at the ends of the bridges was boiled and evaporated away, the staves burning down to the level of the water as it sank. Fish in the streams were cooked; for days they floated, by thousands. Ties were burned out of the railroad track, the rails were buckled and kinked like wire. Everything was swept clean to the tunnel's mouths.

"After 48 hours in this hot dungeon, chief carpenter Lanning walked out, to find 19 of his bridges burned in 48 miles of track. He went to work to replace them. With 500 men, working night and day, he labored. In 11½ days he rebuilt 16 bridges, ranging from 360 to 775 ft. in length, and from 16 to 120 ft. high, every one of them standard permanent bridges. It was one of the most stupendous achievements in the history of railroading.

"Besides that, Lanning alone, has to his credit 500 human lives. He hasn't much to say about it; only this: 'An American owes that to his country and his kind.'"

EDWARD S. MELOY

Edward S. Meloy, an assistant engineer in the engineering department of the Chicago, Milwaukee & St. Paul Railway was born in Waterbury, Connecticut, on March 9, 1860 and died in Chicago, Illinois, on July 8, 1918. He began his railroad career as a rodman with the New York and New England Railroad in 1878, following which he was resident engineer with the N. Y. C. & St. L. Ry., locating engineer with the M. & O. R. R., and in charge of track laying with the B. H. T. & W. R. R., and the C. & N. W. Ry. In the autumn of 1886 he entered the service of the C. M. & St. P., and was located successively at Chillicothe, Mo., Marion, Ia., Milwaukee, Wis., Tomah, Wis., and Chicago, Ill. At the time of his death he was assistant engineer in charge of bridge inspection and bridge erection. In his efficient, loyal and conscientious service of over 30 years he made many friends. The funeral service was conducted by Bishop William O. Shepard of the Methodist Episcopal Church, a warm personal friend of more than 20 years' acquaintance, from whose remarks the following brief abstract is taken:

"Mr. Meloy was a substantial man to lean upon. He was steadfast, loyal, certain and true. You can easily tell that by the fact that he continued in one employment, rising to greater and still greater honor and responsibility, for a third of a century. During all that time, he was constant in doing his part, in his place, with increasing efficiency, —doing his part of the necessary work of the world.

"If I were to try to put into a single word what I thought was characteristic of Mr. Meloy, I think that I should have to use the word 'faithfulness,' or the word 'loyal,' or the word 'constancy.' And I should not be quite satisfied with any one of these words, but should wish to bring in some suggestion of his gentleness, and gentlemanliness. He was one upon whom you could depend. He would not make a rash promise at all. But he would make a promise to a friend, and keep it."

D. C. ZOOK

Dennis Coder Zook was born March 14, 1852, in Wyandot County, Ohio, son of Daniel and Nancy (Steele) Zook, both natives of Pennsylvania. He received his early education in the common schools in the vicinity where he was born. After a thorough knowledge of carpentry Mr. Zook entered the employ of the Pennsylvania railroad on June 1, 1873. Ten years later he was made foreman of a carpenter gang at Valparaiso, Indiana, which position he retained until 1897 when he received the title of master carpenter in which capacity he served with headquarters at Fort Wayne, Ind., until his death.

Mr. Zook had been in failing health for several years but his condition was not considered serious until a few days before his death, when he was removed to the Deaconess hospital at Indianapolis at which place he slept away apparently without pain on the morning of March 28, 1918, from heart disease.

In his long continuous connection with the Pennsylvania railroad Mr. Zook came to be known and respected as one of the company's most venerable and valued employes. His death ends a long career of efficient and devoted service and represents a deep sorrow to his hosts of acquaintances in railroad and lodge circles in Fort Wayne. He was an ardent member of the Methodist Episcopal church and an esteemed member of the Masonic fraternity. He joined the American Railway Bridge and

D. C. Zook

Building Association in 1902, and attended most of the conventions since that time, always being accompanied by his wife.

Mr. Zook is survived by a wife and five children—two daughters and three sons. One daughter,—Edith,—is the wife of F. A. Taylor, master carpenter of the Baltimore & Ohio, at Cumberland, Md.

Interment was at Lindenwood cemetery at Fort Wayne.

ALVA PEYTON RICE

(By Captain Charles S. Dwight)

Mr. Rice was a native of Robeson County, North Carolina. He was born on July 7, 1855. His father was a substantial and respected farmer and a faithful soldier during the entire war in the Army of Northern Virginia under General Robert E. Lee.

When only a stalwart youth A. P. Rice left home with only his father's blessing to seek his fortune in the great world. In that stirring time of rebuilding the war-ruined south, he at once found place with companies of bridgebuilders, whose work was exactly suited to his remarkable strength and untiring energy. In this service he spent many years most successfully, earning high reputation in the construction and erection of many important bridges and trestles on the great railways of the south.

But his best work was yet to be done. In 1903 William G. Childs, president of the Columbia, Newberry & Laurens R. R, appointed A. P. Rice roadmaster. This railroad had been rapidly and cheaply built. It was well located, but it was wholly devoid of ballast and had an excessive amount of wooden trestle which was getting beyond even radical repair. The rapidly increasing tonnage of engines and traffic was proving too heavy for the light rail and "dirt" roadbed. The president wisely decided to ballast the roadbed, and replace wooden trestles with earth,

steel and masonry. Here was the problem of the engineer and the roadmaster, especially the latter. At once Rice's qualities came into play. He was peculiarly gifted in discerning what was needed and where it was most needed, how to get what was needed by convincing the president of the need, and then in using his material most quickly and advantageously; and he had learned, too, that the best material is the cheapest, and would use no other except in emergency.

Beginning with the worst places and working systematically, his labors soon began to tell. Long before his death on December 24, 1917, "slow orders" which had been the bane of the road had become only a memory, entire winters passing without the issuance of one. Rice's ingenuity and resourcefulness were displayed in the building and maintenance of so many temporary structures under which permanent construction was effected; there was never a mishap or failure; in replacing a bridge 2,217 feet long there was not an accident nor a delayed train.

Alva P. Rice was a strong man intellectually and morally. With the

A. P. Rice

most limited opportunity for early education he became a well informed, broadminded man and a useful citizen, attaining these by hard study and extensive reading.

The deep sense of loss that is felt by the president, the engineer and the entire staff of the Columbia, Newberry and Laurens Railroad, and more poignantly, of course, by his own family, is the true measure of his real worth and character.

Mr. Rice married, Dec. 12, 1888, Miss Nannie Elizabeth Maund, of Columbia, Alabama, who, with a grown son and daughter, survives him.

Mr. Rice was a Mason, an Oddfellow, a Knight of Pythias, and a member of the American Railway Bridge and Building Association and of the Roadmasters' Association.

C. A. REDINGER

Charles Austin Redinger was born near Ridgeway, Mo., May 25, 1886, and died at a sanitarium near Boerne, Texas, March 15, 1918. He attended high school in his native town, completing the four year course in three years at the age of 18 He soon afterward went to St. Louis where he secured employment with the circuit court as stenographer and

copyist. Here he began the study of civil engineering, working during the day and studying at night. He took private lessons from Professor Brown at Washington University as well as a course in one of the correspondence schools. Later he secured a position with the Southern Railway and continued in the service of that road until the time of his death. He held various positions in the engineering department and

C. A. Redinger

made good in his work until he was compelled to seek rest at the Boerne sanitarium, where he went in November, 1917, thinking the warmer climate during the winter might be a benefit to his health.

Mr. Redinger is survived by his father and mother, three sisters and two brothers. He was a consistent member of the Methodist church and the funeral was conducted from his home church at Ridgeway.

He joined the American Railway Bridge and Building Association in 1912 at the Baltimore convention.

W. S. DANES

W. S. Danes was born at Belleville, Mich., July 7, 1853, and died February 22, 1918, from apoplexy at the Frances E. Willard hospital, Chicago.

Mr. Danes entered the service of the Wabash railroad in 1880 and the diligence that marked his entire railroad career resulted in promotions successively to bridge foreman, master carpenter, superintendent of bridges and buildings and engineer maintenance of way.

He was widely known and highly respected as a citizen in Peru, Ind., where he had made his home for many years. He is survived by his widow, Alice Cain Danes.

Mr. Danes was a Knight Templar, 32nd degree mason, a shriner, and

W. S. Danes

a member of the American Railway Bridge and Building Association, having joined the latter in 1892, and was its president, 1901-'02.

S. J. POWELL

(By A. H. King)

S. J. Powell was born July 11, 1851, at Winchester, Franklin Co., O., and died as the result of a surgical operation in April, 1918.

Mr. Powell began service with the bridge and building department of the Union Pacific in 1879 and was later transferred to the Oregon Short Line where he occupied the position of division foreman at the time of his death. He was of an exceptionally genial disposition and made friends wherever he went. He learned his trade thoroughly and was rated as a first class foreman. He leaves a widow, three grown daughters and a son in military service in France. Interment was made from the Catholic church at Ogden, Utah.

Mr. Powell joined the Association in 1911.

REPAIRING AND STRENGTHENING OLD MASONRY

COMMITTEE REPORT

Last year's report consisted of a compilation of the replies to the questionnaire prepared by Mr. Gauthier before his departure for oversea duty. Owing to the great stress under which railroad men engaged in construction and maintenance work are now laboring because of conditions brought about by the world war, it was not thought advisable to follow the same plan this year.

As all the members of the committee are now, or have been more or less intimately associated with work embraced by the above subject, they were requested to furnish data from their own experience which could be embodied into a report. Before proceeding, however, with the report proper, prepared from the data submitted, I have deemed it advisable to refer, in more or less detail, to the report submitted by the masonry committee of the American Railway Engineering Association in 1911, in which are given the more common causes of masonry failure, or conditions, the results of which bring about the necessity of repairing and strengthening masonry. While the above report deals particularly with concrete construction, it is applicable in its essential features, to all classes of masonry, and treats this particular phase of the subject in a much broader manner than was done last year.

The following causes are mentioned:

(1) Faulty design.

(a) Where masonry is placed on grillages above the water line, or where the water level is lowered after construction, causing the grillages to rot and allowing the masonry to settle.

(b) Where the grillage rests on piles and where the designer used too high a stress for timbers in compression.

(c) Where the wing walls of U-abutments were built too light.

(d) Where the designer or engineer used too high a unit pressure on the earth, or on piles upon which it was to rest.

(e) Settlement of the body of a structure causing cracks to appear where the wings leave the main portion of the structure or, in the case of arches, at points back of the parapets.

(f) Lack of proper drainage.

(2) Poor material or poor workmanship.

(3) Temperature cracks.

(4) Disintegration of the masonry.

(a) On account of the freezing and thawing of exposed surfaces of masonry, particularly where water drips through an arch ring, or where the masonry near the ground is exposed to alternate freezing and thawing.

(b) On account of masonry being exposed to salt water, alkalies, acids or heat.

(5) Improper filling.

(6) Scouring away of the material underneath the masonry.

(a) On account of unusual freshets.

(b) On account of driftwood, wagon bridges, etc., lodging against the masonry.

(c) On account of ice gorges.

(d) On account of the size of the opening being too small, which causes the water to rise during a freshet, and which increases the velocity of the stream sufficient to scour away the material underneath the masonry.

(7) Material sliding and carrying the masonry with it.

Faulty Design

If settlement resulting from faulty design, cases (a), (b) and (d), is not uniform in large structures they will probably crack unless reinforced so as to prevent settlement cracks. An ordinary single track abutment up to about 20 or 25 ft. in height would probably settle without cracking. If the abutment were built in sections, the different sections would be divided in a vertical plane and prevent unsightly cracks.

In the case of arches (f) under high fills and supported on ordinary soils it is difficult to prevent cracking of the abutments and ring unless reinforcement is used, on account of the pressure on the foundation in the center of the arch being very great when compared with the pressure at the ends of the wing walls. The monolithic character of an arch of standard design is not strong enough to distribute the load uniformly over the foundation and when a slight settlement occurs in the center, it is liable to cause cracks that are unsightly but not necessarily dangerous.

Poor Material or Poor Workmanship

Failures due to poor material or workmanship can be avoided with proper care. Portland cement, as now placed upon the market, is very reliable and few failures can be traced to this important ingredient. The use of dirty sand or a poor grade of stone generally rests with the engineer. Workmanship can not be controlled as readily where inefficient or unskilled labor is employed. However, a competent inspector can generally get satisfactory results.

Temperature Cracks

Temperature cracks will always occur in long walls, although some railroads report abutments built of plain concrete in lengths of 60 to 100 ft., without cracking and when reinforced in lengths of 150 ft. The engineering profession is not now so widely divided on the effect of temperature changes in ordinary monolithic structures and expansion joints are generally introduced at intervals of from 40 to 50 ft. As masonry expands and contracts more than the adjacent material, it follows that it must be built strong enough to overcome the friction or fail.

Disintegration of the Masonry

Disintegration case (a) can be prevented in the case of arches and to a great extent in abutments and retaining walls by proper water proofing which will prevent dripping or seepage and the consequent results of freezing and thawing on the surfaces. Very little protection to exposed surfaces, however, can be provided beyond the use of the most durable material available, placed in a thoroughly workmanlike manner.

Improper Filling

A properly designed monolithic structure will resist failure, due to careless or improper filling, better than a structure built in sections. This is another instance where proper inspection and supervision can be exercised to good advantage.

Scouring of the Material Underneath the Masonry

In designing structures over streams the size of openings should be such as to take care of the maximum amount of water that is likely to come to the opening. It frequently happens, however, that the amount of water is underestimated or that the opening is blocked with driftwood, ice gorges or other material, which either induces scour in the bed of the stream or raises the high water mark or both. Should the scour extend below the foundations the structure is liable to settle forward or bodily downward. A monolithic structure will resist failure bet-

ter than one built in sections, but cracks are liable to occur in either event. Complete failure in many instances can be prevented by relieving the pressure at the back or placing struts across the opening.

Material Sliding and Carrying the Masonry With It

A properly designed monolithic structure will resist failure due to material sliding and carrying masonry with it better than a structure built in sections. However, we have many cases of record where the need of repairing and strengthening old masonry was not brought about by any of the causes above enumerated. Many old structures would have lasted indefinitely had not the weight of rolling stock been increased beyond that for which they were originally designed.

The stresses due to increased loading have been multiplied many times in the case of structures built 50 or 60 years ago, and those which have not failed or shown signs of distress were either designed for much heavier loadings or were exceedingly well built. For this reason one should not be too hasty in concluding that failure was due to faulty design. A case bearing on this point, will be treated later.

We should not lose sight of the fact that engineers today have much more reliable and accurate data upon which to design the majority of modern railroad structures than had the engineers of the early days of railroad construction. Many recent failures of masonry built of limestone, for example, would not have occurred under the loading for which the structures were designed. This stone, except the better grades, will not stand up under present traffic. The same might be said of concrete unless properly reinforced and built of high grade materials of proper proportions.

Attention has already been called in the early part of this paper, to the fact that many masonry failures are not due to any of the seven causes mentioned but to overloading the structures. Very positive proof of this assertion can be found upon looking into the history of two of the oldest masonry structures on the Baltimore & Ohio Railroad. Incidentally these bridges are among the oldest, if not the oldest, railroad bridges of their class, not only in the United States, but in the world.

Gwynns Falls Viaduct, Showing South Portal of Arch,
Original Construction, B. & O. R. R.

The first and oldest of these bridges is a double track stone viaduct having a total length of 297 ft., in the center of which is an 80 ft. semicircular arch spanning Gwynns Falls near Mt. Clare Junction, Baltimore, Md. It was erected by James Lloyd in 1829 of native granite cut to a true surface and laid in lime mortar. The retaining or wing walls forming the approaches to the arch are reinforced at intervals of 25 ft. by massive battered pilasters extending the full height of the structure, the top of which is 65.5 ft. above the bed of the stream.

Instead of filling the space above the arch and between the parapets as is the present day custom, longitudinal brick walls 12 in. thick and spaced 3 ft. center to center, with cross walls of similar construction located at 5 ft. intervals were constructed on the haunches and over the arch, upon which were placed granite slabs 12 in. thick, to form the subgrade of the roadbed. The parapets or side walls originally extended to a height of about 4 ft. above the track grade.

As new ballast was placed from time to time, the track grade was gradually raised, until at the present time, it approximates the grade of the top of the parapets. This and the increased weight of rolling stock, produced a greater thrust against the parapets than they were designed to stand. It was therefore necessary to take down and rebuild the wall on one side about two years ago and the other is now being treated in a similar manner. To prevent a recurrence of the trouble experienced in the past, these walls are being reset with concrete backing extending well back under the tracks to take the thrust from the walls proper. In resetting the face stones special care is taken to place them in their former positions to preserve as far as possible the original character of the structure. Outside of this work, and sealing with concrete the

General View Gwynns Falls Viaduct, Showing Pilasters and Panels in Side Walls

foundation under the west abutment of the arch, which had been exposed by erosion, no repairs have heretofore been made and the balance of the structure, after about 89 years of service, is in an excellent state of preservation. Had the original grade been maintained, it is probable that no repairs to the superstructure would have been necessary for many years to come.

The second bridge above referred to, while not quite as old, is still of greater historical value. It is known as the Thomas Viaduct, and crosses the Patapsco river at Relay, Md., about 8 miles west of Baltimore. It is a double track bridge consisting of a series of eight semicircular arches, each having a span of 58 ft. at the spring line, the

View Showing the Poor Character of Foundation Masonry Under Gwynns Falls Arch as Disclosed When Work of Sealing Foundations Was Done

Thomas Viaduct, B. & O. R. R., Relay, Md.
Built 1833 to 1835

total length of the structure being 612 ft. with a height of 59 ft. above the bed of the river. It was built of native granite in 1833 to 1835.

The subgrade or roadbed of this structure was also formed by the

construction of brick longitudinal and cross walls supporting granite slabs as described for the viaduct over Gwynns Falls. The feature of special interest in this structure, however, is the fact that it is located upon a four degree curve. With the exception of resetting the parapet walls several years ago, which failed for the same reason given in the case of the Gwynns Falls viaduct, no repairs have been necessary, and the balance of the structure is apparently in as good condition as when first built, after about 83 years of service.

From the accompanying photographs and text it will be noted the general designs of the two structures were very much the same, except that in the Gwynns Falls viaduct the exposed surfaces of all masonry were dressed to a fairly smooth surface, with panels introduced in the large blank spaces between the pilasters and above the arch ring, while all exposed surfaces of the Thomas viaduct except the inner surfaces of the ring stones were left with rock face finish.

To the writer the most remarkable feature surrounding these old bridges, is the fact, that when they were designed the equipment in use was undoubtedly lighter than the present day automobile truck. Notwithstanding this fact, they are today carrying as heavy traffic as any bridges in the country, and bid fair to continue to meet growing demands for many years to come. In view of the foregoing, the question naturally arises—did the engineers who designed and built these structures, foresee the possibilities of the wonderful growth in railroad traffic and realize what tremendous loads such structures would eventually have to carry? Whether they did or not, the bridges stand as monuments to the engineers in whose minds they had their inception. For many years they were in a class by themselves and they may never be surpassed.

A case illustrating a failure under Cause VI was described in the Engineering News Record of July 25, 1918, page 186-189, in which is given a report on the repairs of a washout under the Coon Rapids dam in the Mississippi river about 11 miles above Minneapolis, which occurred Sept. 1, 1917. The dam in question was of concrete construction, and extended across the Mississippi river, having a length of about 1000 ft., a height at the spillway of about 21 ft., with a width of base of 27 ft. 9 in. The material upon which it was constructed was a glacial drift formation. The south bank was a so-called hard-pan to a height of about 20 ft. above low water, but in reality it was a mixture of sand, gravel and clay, very hard in places, though easily crumbled in the fingers when broken off in small pieces. It was practically impervious to any head created by the dam. The material, however, had a decided dip to the north and after passing below the river bed it was overlaid by a deposit of clay containing a large percentage of fine sand. The clay deposit, extending in general from the river bed down to the hard-pan, was interspersed with pockets of sand of varying degrees of fineness. Near the north end of the spillway it was overlaid by a deposit of boulders and sand. The failure occurred in this vicinity.

To provide a safe foundation for the dam, wood piles were driven, with bearing values of 10 tons per pile. Cut-off walls of steel sheet piling were placed under the heel and toe of the dam, the sheeting being driven to such a depth as to penetrate at least 5 ft. into material that would be impervious at the head developed by the dam. This depth was determined by test borings, the maximum length of steel piles being 25 ft. A concrete apron extending 50 ft. beyond the toe of the dam, also supported by wood piles, was provided, in the toe wall of which was a line of 8-ft. steel sheet piling to prevent scour from cutting back under the apron.

A power house was located at the north end of the dam above described at the head of an island, in what was a north channel. Formerly this channel, being the deeper of the two, carried probably more than half the flow during floods, but after the plant was built practically the entire flood flow went over the spillway into the shallow south chan-

nel. This condition was a factor in the erosion which took place below the dam. It was assumed that with the high velocity in the south channel, due to its greatly increased discharge, there would be some scour until the river reëstablished a permanent condition of flow.

The dam and power house were completed in Jan., 1914, at which time the gates were closed. The spring flood of 1914, though not of large proportions, carried a quantity of logs over the spillway. Soundings made after the flood showed that considerable erosion had taken place, but not near the apron. It was therefore considered safe to await further developments.

The flood of 1915, considered to have been the maximum for this part of the river, amounted to more than 60,000 cu. ft. per second. Soundings made in the fall showed that irregular scouring had proceeded along the entire length of the spillway. The conditions were such as to make it necessary to provide protection before the next flood. Timber cribs about 24 ft. wide with their tops below the top of the apron were sunk against the toe of the apron for more than half the length of the spillway section.

Soundings made during the winter of 1916-17 showed that the cribbing had been damaged considerably, and that erosion had extended so that protection work of a more extensive character was rendered necessary. After studying the situation with the aid of a contour map prepared from soundings, it was decided that a coffer dam should be built around the hole during the following summer to permit the pumping out of the water and the placing of a concrete floor or paving, after the high water of 1917. This flood carried large quantities of logs and heavy ice over the spillway so that while the flood was not nearly as great as that of 1915 it probably caused more scouring than any previous one.

Construction of the coffer dam enclosing an area below the apron for about two thirds the length of the dam was started in June. On August 11, 1917, the hole was unwatered and by August 31 it was ready for filling with concrete. Up to this time no leakage or seepage had been observed coming from under the dam. However at 2 A. M. Sept. 1, the watchman noticed that the water in the hole was gaining on his pumps and he immediately reported it to the superintendent, but the flow developed so rapidly that the hole was filled with water before anything could be done to stop it, except to open the sluice gates and thus hasten the lowering of the dam level.

Steps were taken immediately to build a rough coffer dam of rock-filled cribs, faced with wood sheeting placed by hand, to obstruct the flow of water under the dam and thereby retard or stop the erosion. In the meantime the ends of the break were covered with brush and sand bags to prevent it from widening. Materials were also ordered for a more substantial coffer dam in the reservoir. Steel sheet piling was obtained from Minneapolis, Buffalo and St. Louis on rush orders and a coffer dam about 350 ft. long extending about 150 ft. up stream was constructed. The piling was driven to a penetration of about 30 ft. and was supported by rock filled cribs 16 and 24 ft. wide.

When the coffer dam was pumped out it was discovered that a hole about 200 ft. long had been eroded under the dam. This hole was about 26 ft. deep in the center and sloped up to the base of the dam at each end. The foundation piles were not undermined so that they sustained the load and no portion of the dam was lost or seriously damaged, nor was there any settlement or sign of distress. The two lines of sheet piling under the dam were not damaged but they were undermined at the break by the washout. Two 54-ft. sections of the apron collapsed because the shorter piles and sheet piling used under the apron were undermined.

In the original construction of the dam the sheeting and foundation piles where the washout occurred were driven from the ice before the coffer dam was built. The sheet piling was driven first. Con-

siderable difficulty was experienced on account of boulders and old logging cribs. There was some apprehension that these obstructions might split the webs of the piles or pull the interlock apart, but nothing of the kind was discovered. However, examination of the sheeting exposed revealed the fact that when one of the bearing piles was driven it had been set on the top of a steel pile, and while the former was badly split, it had nevertheless carried the head of the steel pile to the bottom of the adjacent piles, thus leaving a slot only partially filled by a wooden pile. This condition was either not discovered by the inspector when the excavation for bedding the heads of the steel piles was made or, if discovered, the defect was not remedied by driving a new steel pile. This opening through the cut-off wall is considered beyond doubt the cause of the accident.

Three plans for the repair work were considered, differing principally in detail, each of which presented its difficulties. The principal points to be determined were the bearing value of the clay and the possibility of constructing a new cut-off wall which would tie in with the old cut-off wall beyond the limits of the break. Plan A provided for filling the hole under the dam with 1-3-6 concrete, and facing this on the up stream side with 1-2-4 concrete, encasing the heads of the steel sheet piles of the new cut-off which was to be driven about 5 ft. up stream from the face of the dam. Plan B provided for a similar construction except that the concrete was to be a lean mixture approximating the adjacent hard-pan in rigidity. Plan C provided for a reinforced concrete mat under the dam, upon which cross walls were to be built to support the undermined portion with a reinforced cut-off wall on the line of the old steel cut-off, bearing against the ends of the cross walls and carried well into the underlying hard-pan. The spaces between the walls were to be filled with sand and the apron wall restored in its original form.

The objections to plans A and B were the increased weight and the difficulty of bonding the new cut-off wall with the old, to make it continuous and effective. The original steel cut-off was more than 2 ft. back of the face of the dam and as new steel could not be driven closer than 12 in. there would have been a gap of about 3 ft. between the two rows of sheeting. By slotting the face of the dam it would have been possible to turn the new line of sheeting at right angles to the axis of the dam and drive it up to the old sheeting, but no junction with the old sheeting would have been possible nor would there have been any assurance of contact between the two lines. Plan C would eliminate this difficulty.

Leakage of the coffer dam, however, was the deciding factor and plan A was adopted. The new cut-off wall, as driven, was 175 ft. long. The piling varied in length and was driven into hard-pan. The junction between the old and the new cut-off walls at the south end was effected by excavating a well between the end of the new and the face of the old, down to the bottom of the former. A section of the old sheeting was cut out by a blow torch and sufficient excavation was made behind the sheeting to get a good bond. The well was filled with concrete.

As the cutting of the sheeting and the excavation behind it was very difficult the method of making a junction at the north end was changed. An angle-iron was top-bolted to one of the piles in the old sheeting and the outstanding leg was embedded in the concrete. This method was much more easily carried out and resulted in more satisfactory work.

On account of the close spacing of the bearing piles, the placing of concrete was very difficult except in the bottom of the hole where it could be spouted. In the hope of getting the concrete so solidly packed that grouting would not be necessary, the pneumatic method was employed. Owing to inexperienced help, cold weather and adverse conditions generally the method was not entirely satisfactory. Some segre-

gation of materials occurred as the concrete was deposited, owing to difficulty in the manipulation of the outlet of the discharge pipe, on account of interference of the piles. Wearing away of the discharge pipe was another difficulty experienced. Notwithstanding the difficulties enumerated good work was done and it is considered that pneumatic placing was the only practical method under the circumstances.

In last year's report, reference was made to strengthening a section of the retaining wall between the Chesapeake and Ohio canal and the main tracks of the Baltimore and Ohio at Point of Rocks, Md., during the winter of 1912-13. This work was done by contract, and, to avoid interference with navigation on the canal, it had to be done during the winter when the use of the canal was suspended. This plan also reduced the cost of foundation excavation and masonry which otherwise would have had to be done in about 10 ft. of water.

The concrete plant was erected about 1,200 ft. east of the point where the wall was to be reinforced. The concrete was moved from the mixer to the work in narrow gage Koppel cars hauled by a dinky locomotive. As the railroad tracks were located within a few feet of the face of the wall to be strengthened, it was necessary to erect a trestle upon which to operate the dinky trains. In doing this, one end of the caps was supported on the wall and the other on posts resting in the bed of the canal. On account of having to do this work in mid-winter, the cost of placing concrete was considerably higher than if it had been done in warm weather.

The cost, excluding overhead charges, was as follows:

1,311 cu. yds. foundation excavation, @ $3,	$ 3,933
883 cu. yds. foundation concrete, @ $8,	7,064
1,560 cu. yds. neat concrete, @ $8,	12,488
23,200 lb. reinforcing steel, @ $0.04½,	1,044
Additional work—force account,	72
Refund of passenger fares,	239
Refund of freight charges on plant and material,	656
Engineering,	408
Total,	$25,904

During the winter of 1916-17 a second section of the same wall was reinforced, the work being done by company forces under the direction of S. C. Tanner, master carpenter. The work was begun on November 27, 1916, and completed March 17, 1917, and extended for a distance of about 1150 ft.

The concrete was all placed between January 4 and March 5, 1917, during the coldest weather of the winter, entailing considerable expense to protect it from freezing. Unlike the section reinforced during the winter of 1912-13, this concrete was placed without the use of any reinforcement. The average height of the new work, including foundations, was about 20 ft., and the wall required about 4 cu. yd. of concrete per lineal foot of wall.

The equipment consisted of one locomotive boiler and three 48-in. vertical boilers to furnish steam for operating the plant and heating the materials; two ¾-yard concrete mixers, so arranged that they would discharge into two cars at the same time, on either of two tracks, as might be desired to suit the trains of dump cars; one dinky and 20 dump cars. The concrete was moved to the work, by two 10-car trains, the greatest distance being 1,800 ft.

The stone and sand were dumped, as delivered, on standard equipment into the canal, and then hoisted by a derrick with a 75-ft. boom equipped with a clam shell bucket to the bins located under the mixers. Two bins were used for stone and one for sand. The bins were lined on all sides with steam coils, and exhaust steam from the mixers was passed through the coils, so that both sand and stone were thawed out

before entering the mixers. Live steam was used to heat the water, the result being that the concrete was discharged into the dump cars at a temperature of about 85 deg. during zero weather.

For handling the foundation excavation and moving the forms, which were built in 8-ft. sections, a track was laid in the bed of the canal, upon which was operated a mounted derrick. This equipment was also used to remove the dinky track, trestle work and forms upon the completion of the work.

The accompanying photographs will serve to better illustrate the methods employed, and the conditions under which the work had to be executed.

(Looking East) (Looking West)

Point of Rocks Retaining Wall. Mixing Plant and Storage of Sand and Stone in Canal

Point of Rocks, Md., Dumping Warm Concrete into Forms Near West End of Wall in Zero Weather

Excavating and Underpinning Last Section of Wall

Point of Rocks, Retaining Wall Completed

The following is a detailed statement of the cost of the work:

Erection of Plant—Labor

Clearing ground,	$ 54.00
Building track on which to handle material and equipment,	629.29
Loading lumber (at Locust Point),	89.14
Constructing cement storage houses,	81.21
Unloading lumber,	235.30
Constructing sand and stone storage bins	112.04
Erecting mixing plant (including platform for mixers, setting up mixers, bins for supplying mixers and house for storing cement),	657.92
Setting up derrick,	269.75
Setting hoisting engines,	57.24
Constructing coal bins,	15.14
Loading and unloading mixers,	42.61
Rearrranging mixers to suit local conditions,	54.46
Loading, unloading and erecting pumps and boilers,	495.26

Placing tank for water supply (including piping),	73.01
Loading, unloading and repairing concrete cars,	156.83
Loading, unloading and repairing dinky engine,	70.35
Constructing trestle on which to operate cars for placing concrete in forms,	1,886.19
Constructing sheds over pumps and boilers,	22.45
Trucking ties and rails,	17.30
Carrying water,	3.84
Placing heating coils in material bins and water tank,	241.56
Storeroom labor,	66.01
	$ 5,330.90
Supervision,	266.54
Total,	$ 5,597.44

Maintenance of Plant—Labor

Rēpairing hoisting engines and derrick,	$ 43.95
Repairing mixers,	96.90
Repairing tools and equipment,	151.14
Cleaning boilers,	10.42
Repairing boilers and pumps,	212.59
Repairing boilers (motive power department),	73.93
	$ 588.93
Supervision,	29.45
Total,	$ 618.38

Material Used in Construction of Plant

25 rolls ruberoid roofing,	$ 37.50
10 rolls tar paper,	12.50
Lumber,	160.38
54 kegs nails,	291.60
14 kegs boat spikes,	30.30
2 coils rope,	21.80
24 salamanders,	87.36
Steel cable,	10.48
2 governors for mixers,	40.00
Tools,	32.88
Camp supplies,	23.59
Boots,	101.52
Material (motive power department),	11.17
Pipe and fittings for water and steam lines,	332.24
Pipe and fittings for heating coils,	146.38
Repairs to mixers and boilers,	28.04
4,901 ft. usable 67-lb rail,	1,046.76
390 usable angle bars,	39.00
4 kegs track bolts,	20.00
1 frog,	20.00
1 switch complete,	25.00
Total,	$ 2,518.50

Concreting—Labor

Unloading sand,	$ 352.39
Unloading cement,	202.06
Unloading stone,	350.93
Unloading coal,	177.89

Trucking coal and cinders,	156.14
Operating mixing plant,	1,212.14
Unloading and placing concrete,	1,545.80
Operating derrick and supplying mixers with material,	573.41
Firing boilers,	357.07
Firing dinky locomotive,	189.06
Trucking cement,	267.76
Carrying cement to mixers account of disabled derrick,	158.09
Cutting into old wall for drainage,	26.90
Dressing finished wall,	6.39
Bundling cement sacks,	30.40
Carrying water,	94.98
Thawing pipes,	63.37
Thawing sand,	32.63
Firing salamanders,	217.12
Trucking coal for salamanders,	11.83
	$ 6,026.36
Supervision,	301.32
Total,	$ 6,327.68

Forms—Labor

Building, setting and removing,	$ 2,105.15
Supervision,	105.26
Total,	$ 2,210.41

Forms—Material

Lumber,	$ 558.00
Bridge washers,	10.00
Nails,	48.60
Wire,	81.16
Tar paper,	6.25
Total,	$ 704.01

Plant Rentals

Hoisting engine, @ $150 per mo.,	$ 479.02
Concrete cars, @ $1 per day,	204.00
Labor loading four concrete cars,	6.84
Derrick and clam shell bucket, @ $300 per mo.,	619.35
Loading derrick and bucket,	32.32
Locomotive, 58 days at $5 per day,	290.00
Concrete cars,	40.00
Slewing engine,	50.00
Freight on borrowed equipment,	75.43
Total,	$ 1,796.96

Dismantling Plant—Labor

Dismantling plant,	$ 1,114.96
Removing piping and pumps,	45.33
Loading equipment,	213.20
Cleaning canal,	178.71
Loading cement,	19.30

Loading stone,	45.07
	$ 1,616.57
Supervision,	80.83
Total,	$ 1,697.40

Material used in Concreting

5,269 bbls. cement @ $1.48,	$ 7,798.12
2,876 tons of sand @ $0.40,	1,150.40
3,220 tons of stone @ $0.47,	1,513.40
602 tons of coal @ $1.01,	608.02
	$11,069.94
Credit 20,132 empty cement sacks,	2,013.20
Net Total,	$ 9,056.74

Excavation—Labor

Loading and unloading ties for track on which to operate derrick car,	$ 11.83
Trucking ties for track,	16.24
Laying track,	214.92
Unloading buckets,	1.69
Repairing derrick car,	26.72
Excavating,	1,948.10
Removing track,	102.75
Removing derrick car,	32.60
Removing and burning old ties,	14.00
	$ 2,368.85
Supervision,	118.44
Total,	$ 2,487.29
Work train service (Labor, fuel and supplies),	387.06
Blue Line service,	1.65
Total,	$ 388.71

Credits

2,500 ft. 1 in. by 6 in. Y. P. lumber,	$ 37.50
2 governors,	20.00
Water and steam pipe,	180.67
Steam pipe from heating coils,	59.38
Water and steam pipe fittings,	29.04
Fittings from heating coils,	12.65
Boiler and machine fittings,	28.95
4,901 ft. rail,	1,046.76
390 angle bars,	39.00
4 kegs of track bolts,	20.00
1 frog,	20.00
1 switch,	25.00
Total,	$ 1,518.95

SUMMARY

4,476 cu. yd. of concrete placed at $6.57 per yd.
1,642 cu. yd. of excavation at $1.515 per yd.

Plant—		
Erecting—Labor,	$ 5,597.44	
Material,	2,518.50	
Maintenance,	618.38	
Dismantling,	1,697.40	
Work train service,	387.06	
Blue line service,	1.65	
	$10,820.43	
Credits,	1,518.95	
Net,	$ 9,301.48	
Cost per cu. yd. of concrete $2.08.		
Rental for borrowed equipment,	1,796.96	$11,098.44
Cost per cu. yd. of concrete $0.40.		
Concreting—Labor,	$ 6,327.68	
Material,	9,056.74	15,384.42
Cost per cu. yd. concrete $3.44.		
Forms—Labor,	$ 2,210.41	
Material,	704.01	2,914.42
Cost per cu. yd. of concrete $0.651.		
Excavation—Labor,		2,487.29
Cost per cu. yd. for excavation $1.515.		
Grand Total,		$31,884.57

Cost per Cubic Yard of Concrete—Various Items

Construction of plant—labor,	$1.250
Construction of plant—material,	.111
Engine service,	.087
Maintenance of plant—labor,	.138
Operation of plant,	.775
Dismantling plant,	.379
Mixing and placing concrete,	.362
Sand—material,	.257
Sand—labor—unloading,	.129
Stone—material,	.336
Stone—labor—unloading,	.082
Cement—material,	1.292
Cement—labor—handling,	.048
Coal—cost,	.136
Coal—labor—unloading,	.064
Coal—labor—trucking to boilers,	.036
Forms—labor—constructing, setting, etc.,	.494
Forms—material,	.158
Rentals on borrowed equipment,	.400
Charges incurred acct. winter work	
Installing heating pipes in material bins	
Material,	.020
Labor,	.067
Salamanders—cost,	.018
Labor—operating,	.054
Thawing pipes and sand,	.022
Total cost per cu. yd.,	$6.715

J. P. Canty, division engineer of the Boston and Maine, advises that their custom of repairing old stone masonry has been confined almost wholly to raking out the joints and pinning and pointing them, or in some cases simply pointing. When the masonry is in such condition

that this method will not be effective and economical it is torn down and rebuilt, although in some cases structures have been saved by buttressing and reinforcing bulging or otherwise defective masonry, with iron or concrete or both.

One case in which the above method was employed consisted of a comparatively large stone arch over a stream in which one flared wing about 75 ft. long, bulged to such an extent at the center about midway between the top and bottom, as to make the road uneasy about its safety. This wing was about 35 ft. high where it joined the spandrel wall of the arch and was stepped down from full height near the track, to a height of 4 or 5 ft. at the outer end.

In this case about 15 wooden piles were driven in two rows in front of the wing where the maximum bulge was located. These piles covered a rectangular area about 8 ft. wide and 16 ft. long parallel to the masonry. They were enclosed by a wood coffer dam, which was unwatered and the piles cut off at the water line. The coffer dam was then filled with concrete, and scrap track rails, set vertically at about 2 ft. centers, close to the old masonry, were embedded in it. A block of concrete was then cast, encasing the rails battering from the outside line of the coffer dam to a width of about 3 ft. at the level of the maximum bulge. No movement of the masonry has been noted since this was done about two years ago.

In another case, the crowns of a three centered double track stone arch bridge of two 20-ft. spans laid dry, began to flatten in the center of each arch. This structure was constructed over a stream with the track grade only 3 or 4 ft. above the crown of the arch rings. The abutments, pier and wings showed no evidence of movement or distress. Repairs to this bridge were made by building a temporary wooden deck under the tracks, supported on pile bents back of each abutment and a timber bent over the center of the pier to carry traffic. This construction permitted the removal of the earth filling and ballast from the tops of the arches.

Timber forms made to fit the original curve of the arches were placed under them and the deformed arches were jacked back to the original shape and position. All joints were washed out clean with a force pump and thoroughly grouted with cement. An examination of the structure disclosed the fact that the thickness of the abutments at the spring line was not sufficient to stand the thrust of the arches according to accepted practice and additional concrete was added to provide for this. The earth covering was then replaced on the arches and in the rear of the abutments and the false work removed. This work was done about 10 years ago and no settlement has since been noticed.

Stone masonry piers which showed evidences of failure have been repaired and strengthened by placing track rails in pairs, vertically on each side of them, tying them together by placing rods through the piers between each pair of rails, secured to the rails by heavy bent washers on the outside of the rails, with nuts on each end of the rods. The entire piers were then encased in concrete 12 in. to 18 in. thick and have since given satisfaction.

Repairs to high spandrel or parapet walls on old stone arches, carrying single or double tracks which have been pushed out by the increased weight of rolling stock, have been repaired by drilling holes in pairs through the spandrel walls opposite each other about 4 ft. below the tops of the ties, excavating trenches under the tracks opposite the pairs of holes and providing rods about 1½ in. in diameter with turn buckles in the center and nuts on each end. These rods were anchored to the faces of the walls by pairs of rails as above described, or by heavy iron plates set in the face of the masonry. The nuts and turn buckles were then screwed tight and the rods encased in concrete.

Repairs to concrete masonry have been made by cutting out the defective concrete and replacing it with good material.

A. S. Markley, master carpenter of the Chicago & Eastern Illinois, during the discussion of this committee's report last year presented a very complete report on repairs made to a number of structures on the lines of his road. This year he furnished notes on repairs made after a washout at bridge No. 1408 from which the following report has been prepared.

This bridge crosses the Vermilion river at Cayuga, Indiana. As originally constructed in 1871, it was a single track through truss bridge 178 ft. long. In 1903 it was converted into a double track structure by extending the pier 14 ft. on the down stream end. The extension to the pier was built of concrete, the foundation of which was carried to solid rock. The original pier, built of stone in 1871, was supported on piles about 14 ft. long, driven to rock, upon which was placed a timber grillage of the usual construction.

In 1913 a washout occurred which removed the sand and silt from between the piles under the pier and in addition, knocked out several piles. This permitted the pier to settle and crack. Traffic was immediately diverted to the north-bound track, which was supported by the 14 ft. extension resting on rock and which had not been disturbed. To prevent the total destruction of the old portion, if additional piles should fail, it was clamped to the new part by placing 1½ in. rods parallel to the sides of the pier, with timbers across the ends. By this process the old part was held firmly to the new and traffic resumed on both tracks.

A coffer dam of Wakefield sheet piling was placed around the entire pier. All loose material remaining between the piles and on top of the rock bottom was then removed, leaving a cavity about 11½ ft. deep by the horizontal dimension of the original pier, between the bottom of the grillage and the top of the rock. Using the walls of the coffer dam as a form this cavity was then filled with concrete, thoroughly grouted under the grillage. The concrete was then carried up around the outer edge of the grillage, sealing the concrete against the bottom course of masonry to the timber grillage.

The estimated cost of making these repairs was $2,000. The actual cost was $1,780.

In last year's report Mr. Markley gave cost data covering the strengthening of five piers and the south abutment of bridge 1634 over the Wabash river at Clinton, Ind., showing the cost of labor and materials for forms at $3.33 per cubic yard of concrete, and the cost of labor and material per cubic yard of concrete in place at $10.89. This year he furnished a detailed statement of the cost of repairing the north abutment of this bridge, which work was done at about the same time as that reported last year, as follows:

Concrete in foundation,	42.3 cu. yd.
Concrete above foundation,	210.0 cu. yd.
Total,	252.3 cu. yd.
Foundation excavation,	204.4 cu. yd.
Concrete in two bearing blocks,	18.5 cu. yd.
Cost of excavation per cu. yd.,	$0.833

Cost of Various Items per cu. yd. of Concrete

Forms (labor $1.868, material $1.499),	$ 3.367
Cement,	1.933
Reinforcing bars,	.946
Labor concreting,	3.177
Material concreting,	2.908
Setting reinforcing bars,	.214
Cutting and drilling,	.534
Bearing blocks,	5.106
Placing bearing blocks,	10.017

The average cost per cu. yd. of concrete was, labor, \$6.775, material, \$4.392, total, \$11.167.

Recapitulation

Bearing blocks	Labor	Material	Total
Making,	\$ 35.50	\$ 58.97	\$ 94.47
Placing,	166.90	18.41	185.31
North abutment,			
Excavating,	170.30		170.30
Forms,	471.41	378.25	849.66
Setting bars,	54.13		54.13
Cutting and drilling,	134.74		134.74
Concreting,	801.72	733.69	1,535.41
Totals,	\$1,834.70	\$1,189.32	\$3,024.02

C. H. Fake, engineer maintenance of way, of the Mississippi River and Bonne Terre, seems to have been more fortunate during the past 22 years than most engineers occupying similar positions and your chairman is unable to determine whether to commiserate or congratulate him. It is feared he does not know what he has missed in not having a lot of poor masonry to repair or rebuild, this being a class of work often taxing one's ingenuity and resourcefulness to the limit to accomplish.

While it has been his good fortune to have had to make no repairs to masonry on the road with which he is now connected, he advises that prior to becoming associated with this present company he was for a few years with the Missouri Pacific, which has a great deal of poor masonry. When repairs to this masonry were necessary it was generally found to be in such unsafe condition as to require rebuilding. Its condition was due to one of two or three causes.

First, much of it was poorly constructed, laid with very close joints presumably in lime mortar, practically all of which had disappeared. The backing was not grouted or properly filled with mortar and while the face stones were reasonably well cut they practically rested on one another with no mortar bed between them. Second, the stone as a rule was local limestone which did not "weather" well and much of it cracked, either from weather conditions or poor bedding. Third, much of it was damaged by fires caused by the burning of wooden bridges during the Civil War, first, from the Confederate side and then from the Union side. The heat from these fires badly spawled the face stones of the walls and in many cases practically destroyed them. In some cases where the damage was not too great, the copings were removed, face joints pointed up and the body of the structure filled with a thin grout. In other cases damaged stones were removed and the spaces filled with concrete.

DISCUSSION

(Repairing and Strengthening Old Masonry.)

L. D. Hadwen:—The thing that impressed me most in the reading of this report was the fact that prevention is so much better than the cure. I think that while all the rest of the bridge structure undergoes a very rigid inspection, the masonry doesn't receive the same care and upkeep as the other parts of the structure. Frequently bridges are subjected to much heavier loads than those for which they are originally designed. The steel work is strengthened accordingly but nothing is done to the

masonry. Afterwards such defects occur as have been called attention to in this report. If, at the time the steel were strengthened, steps had also been taken to reinforce the masonry, no aggravated damage would result.

In this connection, nothing is mentioned in the report as read in regard to drainage back of the structure. A great deal of trouble with old masonry has been due to the fact that water gets pocketed behind the structure and causes damage. In many cases providing weep-holes in a high wall will prevent trouble from that water, particularly when the material used for backfilling is clay and material of that character.

A very effective way of repairing old masonry, as has been mentioned in the report, is by grouting but in many cases it is possible to jacket the masonry with reinforced concrete and to use some modern grouting plant whereby you can force grout throughout the structure possibly at a pressure of 100 or 200 lb., depending on the conditions.

I was surprised recently, in making repairs to a fine piece of bridge masonry, to find that, although it was built under first class specifications, it was possible to force quite a little grout into it by driving holes into the upper portion and using a grouting machine. In this particular case damage had resulted to the top of the pier. Repairs were made by encircling a few of the upper courses of the pier masonry with heavy rods which were tightened up by means of turnbuckles which went entirely around the course, the rods were encased in a jacket of reinforced concrete and after this reinforced jacket of concrete had set up, holes were drilled through the jacket and the body of the pier and heavy bolts run through to tie the masonry together.

Finally vertical holes were drilled in the top of the pier and the pier was grouted as mentioned previously. A very satisfactory job was the result.

Another phase of the repair problem has not been mentioned in the reading of this report. That is the possibility of reinforcing old culverts of rubble masonry and old arches by a concrete lining. In cases of this kind where a culvert is concerned we have found it better, if the water way conditions permit, to encroach a little on the waterway by cutting out somewhat on the side walls and building a reinforced concrete box capable of taking the load irrespective of the old masonry, letting the old masonry simply stay.

With respect to the bridges on the Missouri Pacific about two or three years ago I remember that Mr. Smith gave us some very interesting data in regard to the repairs which had been made under his supervision as consulting bridge engineer for the road. He emphasized the fact that many times instead of going to a very large expense and tearing out old masonry they had overcome the difficulty by making comparatively cheap repairs.

I think the tendency sometimes is to exaggerate the seriousness of the condition of old masonry; we condemn it and say we've got to pull it down when we really could carry it by devising some scheme of repairs. It seems to me that this is a point to be considered now when labor is so scarce and when we want to reduce our work to a minimum. We should try and carry old masonry structures rather than tearing them down and substituting something new.

Lee Jutton:—This question of repairing old masonry is one in which every railroad is undoubtedly very much interested. We all know that the motive power has been increased in weight, the load has been increased over structures and invariably the superstructure has either been reinforced or renewed with a heavier superstructure. That problem is not particularly difficult to solve but it is always a question what to do with the substructure. I believe that more expert inspection is necessary in connection with the substructure than with the superstructure. I believe, also, as Mr. Hadwen has said, that we often condemn old masonry a little too soon. I know that it is surprising what old masonry will carry after it has developed cracks and opened and settled a little bit, perhaps, but it still seems to do the work.

I want to mention one case of an old masonry arch built away back in the '60's. It was considered that this old arch should be encased in concrete as it was constructed of small and irregular stones and the mortar was coming out of the joints. It had been pointed and repaired and fixed up and plastered up; no particular weakness was visible but everybody agreed that the structure ought to be repaired and plans were made. It developed, however, that the farmer across whose land this road was running had a cattle pass there and held the rights to the bridge and he saw his chance to get a little money so he told us that he would not permit the reduction of the opening. That started us to thinking again and we decided that his claim was entirely out of reason and that he was not entitled to any consideration. After further consul-

tation it was decided to let the arch remain. It is a hard looking old structure, as I said before, but no particular weakness is evident and it is carrying the largest locomotives that we have in use.

Sometimes foundation matters are rather misleading and it is hard to determine just what to do with them. I had a little experience with a turntable foundation. It was on very hard clay which was practically impervious. It was tested with a load many times greater than the load that was to be put on it. Nevertheless, after the thing had been built it wasn't long until a little trouble developed at one corner. A good many attempts were made to save the structure but after a time it finally had to be blown up with dynamite and rebuilt.

I mention this merely to emphasize my original point that the handling of substructure problems, the strengthening of old masonry or the carrying of old masonry beyond the point where it might be first considered that it should be taken out is one that needs careful study. We all know that in these times of conservation we should give such problems very careful study and that before we make up our minds to tear out an old structure we should analyze it from every point of view. If that is done we will probably carry old structures over which otherwise we would have to replace.

W. E. Alexander:—Mr. Hadwen spoke about prevention being better than cure. I agree with that idea thoroughly. It has been said here in connection with the strengthening of old masonry that the backfilling and weep-holes in the walls have a great deal to do with the protection. I am located in a cold country where we have a great deal of frost and where the action of frost in the wet clay against masonry is very serious. We have found that the best backfilling against masonry or concrete walls or structures of any kind is locomotive cinders. They are porous and the water will work down and out if there is any chance.

F. E. Schall:—I want to say a few words in regard to what Mr. Hadwen said about grouting. We have done considerable work of this kind and we find it advantageous in walls that are very old to pick out four to six feet and drill in and grout that portion, then go up four to six feet more and drill in again to the heart of the wall and grout that. If the grout has to run for long distances it will choke up and you won't get quite as much benefit by trying to grout the entire structure from above.

In regard to the failing of old masonry, the principal defects that we have are the foundations. The old railroad pioneers did not go down deep enough or make the foundations wide enough. There is too much pressure on the soil. We have been underpinning our masonry with concrete in sections. We go right under the masonry 18 in. to 2 ft. and make it in sections only. We take out a section in the middle and then go about ten feet away and take out another section. In that way we can prevent our wall from tilting and at the same time underpin the structure.

As far as the motive power is concerned, the total weight of the masonry is usually so great as compared with the weight of the rolling stock passing over it that there is little danger of the masonry failing unless the foundations are bad.

P. J. O'Neill:—I have had a failure of a turntable by reason of the base of the foundation of the center being down in the clay and the impact of the engine rocking it, very slightly at first no doubt, but increasing as time went on. I remedied that by driving piles and inserting I-beams. This was a stone foundation and I think the trouble was caused by the fact that when we excavated into the clay and dropped stone in we simply made a clay pocket there to hold the water which gave an opportunity for it to puddle.

We have another turntable with a concrete foundation which we put in in a somewhat similar way though we haven't put any I-beams on it. We have cut it away at an angle of about 45 deg. and have filled it in with reinforced concrete. It is on a clay foundation somewhat similar to the other. We have poured concrete in and tried to fill the space absolutely, to allow no place for water to soak in unless it went through the clay which is practically impervious. We are hopeful that that will be successful, although we have no conclusive results as yet.

I would like to ask Mr. Hadwen what effect the 200 lb. pressure per inch on his grouting has had on the facing, the slab that is bolted on. Have you ever found that it was forced off?

L. D. Hadwen:—I have not used that high a pressure except where the masonry is very good.

A. Montzheimer:—Perhaps it might be of some interest if I would tell of the plan we followed in reinforcing the center pier of a drawbridge over the Grand Calumet river at South Chicago about a year ago. This pier supports a 240 ft. double track drawbridge and was built in 1869. At that time the river was

only about 16 ft. deep and the pier was built on a pile foundation. The piles were cut off under water, level with the bottom of the river. On account of the bridge being close to Lake Michigan it was difficult to get the piles cut off evenly, the wind causing rough water and making it difficult to get an even height for all the piles.

After these piles were all cut off a crib was floated on and the masonry built inside the crib; later the river was deepened so today we have about 22 ft. of water. The piles of course now project about 6 ft. above the bottom and have no bracing whatever, which caused a great deal of vibration. If a boat struck the center pier the whole structure would rock back and forth.

It was found necessary to do something and on account of the very heavy traffic there it was almost impossible to put the bridge out of operation. We therefore went in and drove steel sheet piling all around this center pier, widening it only about a foot on the channel side, although the ends of the piers were lengthened about 8 or 10 ft. Inside of this sheet piling we drove additional piles and later filled the entire cofferdam with concrete without pumping out the water. We secured a very fine job and I am satisfied that the concrete is just as good as though it had been put in within a dry space. On account of conditions there it was practically impossible to drive out the water.

We also put in a new turntable over the bridge which was done in, as I remember it now, about 72 hours actual time, the traffic being turned over another road while the turntable was being put in. Today we have practically a new bridge and all done without in any way tearing out the old structure. The results certainly warranted us in doing the work in that way.

J. P. Wood:—I was much impressed with one remark by Mr. Jutton. I believe that in times gone by too much attention has been given to tearing out old masonry where it could have been carried over. Because some of it started to go wrong or scour somewhat in years past, the idea with a great many railroads was to take it out and renew it whereas I believe the past year's experience shows that it would still stand for a number of years without any labor or material for reinforcing whatever.

We have a double 12 ft. brick arch at Ionia, Mich., erected about 1881, used for the purpose of carrying off overflow. During times of flood it carries water in great volume and also considerable ice in the early spring. The roadmaster called

my attention to it about six years ago at which time he said he thought it was in very bad condition. I made a thorough examination and was satisfied in my own mind that it would carry traffic safely for years without rebuilding or repairs. I examined that structure the past season and without any repairs I believe it is perfectly safe for several years more. With proper supervision and by the exercise of good judgment many structures may be carried for years with very little or no repairs.

The President:—The subject of repairing and maintaining old masonry is very important. I think in this connection that I might say a little in regard to Mr. Strouse's report on the Gwynns Falls bridge. I happen to have been connected with the repairing of that structure. In digging down to the foundation we found that this mammoth arch (and a beautiful one at that) was built on stone put on top of a double foundation with apparently no mortar whatever. We dug down and found an openwork—just a lot of stone put up and an acute arch put on top of it.

However it stood up until just about two years ago. I took it in hand at that time and built a wall outside on which to build a footing course. We pumped it full of grout which seems to have made a permanent job of it. As far as we can see it should now last indefinitely.

The walls along the arches and the parapets were finished smooth on the inside the same as the outside, and were put up as a protection to keep men from falling overboard and also as an ornament. From time to time the track was raised until it pushed the walls over, so we had to repair them. Their original line was straight and we tried to maintain the original construction.

This goes to show the fruits of the work of the track forces, raising track indiscriminately. There was no need to raise track there and if they had not raised the track all these years they would not have had to repair these walls. I think it would be a very good thing not to raise track over bridges of this character.

Those bridges were all drained when they were originally built. Holes were bored on several occasions to determine whether they were still solid. My attention was called to the fact that the bridges were falling because of the holes.

The work Mr. Strouse had in mind in his reference to the repairing of the old wall was on an old dry stone wall. As it was very close to the main track the wall became much shattered. While Mr. Strouse refers to this work being contracted, this

was not the case as I had supervision of it. We put all that concrete in there for 150 ft. of wall, averaging about 12 ft. high in 31 days, commencing the 4th of January and finishing the 5th of March. We came through without any frozen concrete and it protected and strengthened the structure until now it will apparently stand forever.

There is an old piece of masonry, an aqueduct on the Chesapeake and Ohio Canal, just west of Washington Junction, that has a break right in the middle of the arch, which has been there a good many years. The main arch is about a 30 ft. arch and has two small ones on each side, about 12 ft. wide. The main arch commenced to break down in the middle by the lighter arches giving away. They reinforced it by strutting it with timber. It leaks a little, but it is doing the business.

SOURCES OF RAILWAY WATER SUPPLY

COMMITTEE REPORT

Two essential features of almost equal importance must be considered in the selection of a railway water supply; quantity and quality. It is obvious that the supply must be sufficient in quantity, but secondary only to an ample supply is the question of quality.

The successful operation of a railroad using steam as a motive power requires that the supply of water be equal to the demand at all times. The consumption will vary greatly and the available supply should be sufficient for the maximum requirements with a safe factor to provide for future increased consumption. The quantity of water required is dependent on the number and size of the engines taking water, the tender capacity of the engines, the tonnage of trains and the distance between stations. Provision should also be made for water for other than locomotive supply at terminals and other points where such water is required. The immediate supply should be sufficient for a demand at least 50 per cent over the normal requirements to provide for fluctuations in consumption and extraordinary movements of trains following temporary obstruction of traffic or other reasons.

In considering a source of supply accessibility is secondary to the quality of the water. An ideal water for locomotives is one that will not form scale or cause corrosion, pitting or foaming. Unfortunately nature does not supply a water entirely free from these effects, but in many cases they can be minimized by a careful selection of the supply. Consideration should always be given to the quality of the water rather than to the convenience of location.

No figures are available as to the sources of water supply of American railroads, but the following statistics concerning municipal supplies are given by the U. S. Geological Survey, quoting from the Journal and Engineer, Vol. 24, No. 19, May 6, 1908: "In nearly 400 cities located in all parts of the United States and Southern Canada, 40 per cent of the public water supplies are drawn from wells; 25 per cent from lakes, ponds or springs, 24 per cent from rivers, and 11 per cent from mountain streams impounded or otherwise. In 56 out of the 93 cities in the Ohio River valley, and 46 out of 85 cities in the Upper Mississippi River valley water supplies are derived from wells. Of 131 cities in the New England and Middle Atlantic states 56 take their supplies from lakes or springs; 28 from wells; 26 from mountain brooks; and 21 from rivers. The total volume of water taken from other sources is, of course, greatly in excess of that taken from wells."

While municipal water supplies are used for domestic purposes rather than for boiler supplies, the various sources of municipal supplies may be taken as a fair average of the sources of water used for railway purposes, for the reason that the railroads are compelled to look to the same sources of supply as the municipalities through which they operate, in many instances taking their supply from the cities and towns along their line.

The water supply of any region, except the deep underground waters from porous beds which are supplied from a source perhaps many miles away, is abundant or deficient according to the character of the rainfall. Water falling as rain may be divided in three parts, (1) A part of the precipitation flows into the lakes and streams and to the sea. (2) A part is held by the vegetation and soil and is evaporated by the sun directly, or through plant growth. (3) A third portion is absorbed by the earth and penetrates the pores and fissures in the rocks, loose sands and clays below the surface, accumulating in the porous stratum from which it is secured by sinking wells.

The normal rainfall throughout the country has been estimated by the United States Weather Bureau at 29 in., and the area is divided in this respect into the following classifications: Deserts, or arid lands 10 in. per year; semiarid, or light rains, 10 to 25 in.; moderate, 25 to 50 in., copious, 50 to 75 in., and excessive above 75 in. According to the latest record less than 6 per cent of the area of the United States is in the excessive rainfall class, exceeding 75 in. annually, 16 per cent ranges from 50 to 75 in., 25 per cent from 25 to 50 in., 30 per cent from 16 to 25 in. and 20 per cent less than 10 in. It is upon these figures that the normal average of 29 in. per annum is based. The difficulty in providing an ample supply at all seasons from many of the streams and other surface supplies lies in the fact that the rainfall is not equally distributed throughout the year, and during the period of drouth, or of little rain, the smaller streams and water courses fail, often causing a heavy expense for hauling or securing water from other sources.

Streams

Small streams, if sufficient in quantity, present but few difficulties in establishing a pumping station. On rivers and the larger streams, where the stage of water varies beyond the limits of ordinary suction lift the proper location of pumps with reference to the varying stage of water is essential to satisfactory operation. The pumps are sometimes placed in water-proof pits within easy suction lift of the water at the lowest stage. Also facilities are sometimes provided for raising and lowering the pumps with the varying stages of the stream. The former method is decidedly the better one as, where the pumps are moved with the river stages, the station is little more than a temporary affair, and the costs of operation and maintenance are excessive. Streams usually carry considerable matter in suspension and the problem of protecting the intake lines from mud, sand, leaves, etc., is quite important. The matter carried in suspension by the water of streams may be removed readily by settling basins or filtrations, and the water is usually of a good quality except where the streams are polluted by sewerage or industrial wastes. Smaller streams are often affected by organic and vegetable matter, especially after a prolonged dry period followed by light rains which bring the troublesome matter into the streams, but do not flood the streams sufficiently to carry the impurities away. This condition accounts for a great deal of the trouble experienced from foaming and pitting, by water that is usually considered a good boiler water.

When the supply is from a small stream, whose normal flow falls below that necessary to supply the demand during certain seasons, it is frequently necessary to build impounding reservoirs in which to store the heavy spring and fall flows for use during the low periods of summer and winter. If the pump capacity is in excess of the flow, damming the stream will permit of securing the full supply by running the pump only a portion of the time, and at convenient periods instead of constantly.

Lakes

The smaller lakes and ponds usually offer the most favorable conditions for establishing pumping stations, both as to construction and quality of water. They are affected but little by storms, and difficulties from the effects of currents common with the larger lakes are not encountered. While the quality of the water of the large lakes is uniformly good the effects of currents and storms sometimes cause a great deal of trouble from turbidity and sewerage pollution, as well as stoppage of intakes, if they are located near the shore. Very few, if any, intakes of railway water stations are located very far from shore or breakwaters, and as the shores of lakes in the vicinity of cities are constantly being extended, chiefly through the dumping of rubbish, these intakes are a continual source of trouble and expense. The intake of one railroad

pumping station in Chicago, pumping from Lake Michigan, has been relocated four times and extended 200 ft. in 10 years. Where the water was 18 ft. deep 10 years ago, it is now 3 ft. deep and constant care is necessary to keep the intake from being covered by rubbish. During stormy weather or periods of inshore winds a large force of men is required to keep the intakes and strainers clean. As much as 20 tons of material has been removed from this intake in 10 hours. This condition has been brought about by the dumping of rubbish by the City and emphasizes the necessity of extending intakes well out in the lake, where they will not be affected by conditions along the shore.

Reservoirs

Impounding reservoirs are frequently found necessary for the storage of water when a suitable supply is not available from other sources. The most economical and satisfactory method of constructing an impounding reservoir is by damming up a valley if one may be found suitable for the purpose. The cost of excavating for a reservoir or constructing it entirely of stone, brick or concrete is prohibitive where the storage of several months' supply is required. Where the reservoir is dependent either on a stream or water shed for supply, the storage should be sufficient to provide for the evaporation and absorption that will take place in addition to the normal consumption. The evaporation will vary greatly with different reservoirs. The factors to be considered are, the humidity, area of reservoir, depth of water, temperature, proximity of forests and other local conditions. The absorption will depend entirely on the character of the surface and sub-strata, and unbroken sub-strata of clay or hard pan form the best possible bed for a reservoir as the absorption through a formation of this kind is less than through any other than an impervious rock. Where a limestone formation prevails, care should be taken to see that there are no sink holes or fissures in the submerged area through which the water might escape. The rainfall will have to be considered carefully in connection with the watershed to determine the catchment area required. The size of spillway will depend on the rainfall and catchment area and should be large enough to take care of the maximum run off over the entire catchment area.

The amount and distribution of the rainfall in the United States is given by M. L. Fuller in the U. S. Geological Survey Water Supply Paper No. 114, 1905, as follows:

"In the Eastern United States the rainfall is plentiful, the yearly average varying 20 to nearly 80 in. Rain to a depth of more than 60 in. a year falls on the Mississippi Delta below New Orleans and along the Gulf Coast from near Mobile, Ala., to Tallahassee, Fla. A nearly equal amount falls in the higher mountains of Western Carolina and Eastern Tennessee, along the coast of North Carolina and in the Adirondack and White mountains. In the Gulf and South Atlantic States the rainfall is between 50 and 60 in. a year, in the New England, Central Atlantic and Ohio River States, between 40 and 50 in., in the Upper Mississippi and Great Lakes States between 30 and 40 in., and in Northwestern Iowa and most of Minnesota between 20 and 30 in. In the Western part of the United States the distribution of rainfall is much more irregular than in the Eastern part. Westward from a line drawn through the Eastern part of the Dakotas, middle Nebraska, Western Kansas and Central Texas the rainfall decreases to less than 20 in. yearly, all of the Great Plains region being characterized by small rainfall. In the Black Hills, Bighorn mountains, and the higher sections of the middle chains of the Rocky mountains the rainfall is 20 or 30 in. yearly, and in the high Sierras, the Cascade, and the Coast ranges it is 70 in. or more, reaching a maximum of 150 in. in the Coast ranges of Oregon. In the Great Basin between the Sierra Nevada and the Wasatch mountains the rainfall is

less than in any other section of the country, in places being as low as 2 or 3 in. a year."

The care of the catchment area or watershed is an important factor in determining the quality of water secured from a reservoir. The most effective method of protecting the quality of an impounded water supply is to purchase the entire catchment area. This is hardly ever practical, or possible, the chief objection being the cost, as the water shed will usually cost many times more than the reservoir. The desired result may be accomplished in most cases by acquiring all the land around the reservoir within a certain distance of the water's edge. If this strip is kept well sodded it will assist materially in improving the quality of the water, as it acts as a strainer or baffle, and prevents impurities entering the reservoir. In preparing a reservoir site for water, it is very important that all timber and plant growth be removed from the flooded area to prevent contamination of the water through certain forms of vegetable life commonly known as algae.

The dam is perhaps the most important feature in connection with an impounding reservoir and too much attention can not be given to its construction. The foundation must be sufficiently firm to prevent the settling of the dam. The connection between the foundation and the dam must be of the best to prevent leakage and shifting, or sliding, as, if the connection is not good, a part of the dam may slide out under pressure. Dams are constructed of various materials such as wood, concrete, stone and earth. Earthen dams are most commonly used on account of their cheaper construction, and when properly built are quite as satisfactory as any other construction. There are several different methods of preventing leakage through, or under the embankments of earthen dams, the one most employed being a puddle wall carried from several feet below the base to the top of dam. The thickness of the puddle wall depends on the height of dam. Other methods of preventing leakage and strengthening dam are to drive a row of sheet piling through the center of the fill, or to construct a concrete core wall. Sometimes low retaining walls of concrete are placed along each toe of the slope, these walls assisting materially in preventing damage to the dam and adding to the appearance. The slope of the embankment will depend largely on the height, although it is usually carried 3 to 1 on the water side and 2 to 1 on the down stream side.

It is not the intention to devote any space to a discussion of the design of dams, as each installation will have to be considered in view of local conditions, the above being merely suggestions as to general practice.

Edward Wegman, writing on masonry dams in the American Waterworks Association Proceedings for 1913, gives the cause of failures of five high masonry dams as follows:

Year	Name	Location	Height	Cause of failure
1802	Puentes	Spain	164 ft.	Pile foundation
1881	Hobra	Algiers	110 ft.	High flood—poor masonry
1895	Bouzey	France	72 ft.	Pervious sandstone foundation
1900	Austin	Texas	68 ft.	High flood—poor foundation
1911	Austin	Penn.	50 ft.	Pervious foundation

It is interesting to note that in four of the failures above mentioned the cause was attributed to poor foundations. It is apparent that the success of a dam depends on the foundation quite as much as the dam itself.

Wells

A deep well is not always the most satisfactory method of securing water, as, where the head is far below the surface, the cost of raising the water is excessive, but surface conditions are often such that the only available water supply is that secured in this way. Well waters, as a

rule, are pure and clear, although many are very hard. A hard water is not objectionable for drinking purposes, but is unsatisfactory for boiler use. The majority of well waters respond readily to treatment and as a well is usually drilled only when all other possible water sources have failed, there is no choice, other than to use the water in its natural state or resort to treatment.

There is a great deal of superstition and guesswork among well drillers, and others, relative to the proper location of wells. A popular fallacy is the indication of water through the fancied movement of a branch or twig of a tree when carried over an underground water supply. It is also a common belief that the head of water increases with the depth of the well, or that flowing wells may be secured anywhere if the wells are sunk to a sufficient depth but experience has shown that the sinking of wells far below the principal water-bearing strata has commonly resulted in highly mineralized waters, rather than an increased head of flow.

An intelligent knowledge of the presence of underground water can be secured only by a careful examination of the locality in which the well is desired and of existing wells in the vicinity. From the existing wells and local geology, it is often possible to determine the exact depth of the water-bearing strata and the quantity of water it is possible to secure, as well as the quality of the water.

The ground water level has lowered decidedly in certain sections of the country. While this decline has not been confined to any particular section, it has been marked in Indiana, Southern Michigan, the Great Plains and in Southern California. It is also noted that an artesian well was drilled in Chicago in 1864 in which the water rose to a height of 80 ft. above the surface of the ground or 111 ft. above the surface of Lake Michigan. The flow in this well has long since ceased and the head has declined until the water stands 20 to 30 ft. below the surface, a loss in head of 100 to 110 ft. This loss of head may be accounted for in part through the reckless waste of ground waters from flowing wells. A great part of this waste is from the casings of old oil wells. In many sections of the country especially in Mississippi and Louisiana, hundreds of artesian wells are allowed to flow constantly to no purpose, wasting large quantities of the best ground waters. In the Southern States, with the possible exception of Florida, this waste does not appear to have materially affected the ground level of the water, but it is only a question of time until the loss will be seriously realized.

The following discussion on the amount of available underground water is taken from U. S. Geological Survey Water Supply Paper No. 257, entitled "Well Drilling Methods, 1911," by Isaiah Bowman.

"In most cases it is necessary to penetrate some distance below the earth's surface in order to reach a zone saturated with water, the actual depth depending on the amount of precipitation, the character of the rock, and the topography. The depth is least in regions of much rainfall and is greatest in arid regions. In general it is least in valley bottoms and greatest in the higher lands. In some localities, as at springs and in marshy lands, the plane of saturation coincides with the surface, but the existence of ground water at the surface is due to exceptional conditions. The lower limit of penetration of water depends on a number of conditions. The limit to which water will penetrate is the depth at which the weight of the overlying rock becomes so great that pores between the particles can not exist. This depth has been theoretically placed at about 6 miles. Practical experience in well drilling, however, does not prove the assumption that all rocks are saturated below a moderate depth. In the Pennsylvania and New York oil regions, for instance, rocks that are practically destitute of water are encountered at a depth of only a few hundred feet. These rocks include coarse grained sandstones capable of holding large amounts of water, yet as far as can be determined they are quite dry, so that it is necessary in

some wells to pour in from the top the water required in drilling. In some parts of these oil fields, the drill enters rocks containing salt water after passing through these water-free rocks, but fresh water is very rarely found below the dry rocks. In some places wells have been drilled several thousand feet without encountering water below the first few hundred feet, but, although the rocks thus penetrated are far from being saturated, they doubtless hold slight amounts of moisture. These facts show the fallacy of the popular idea that there is plenty of water if one only goes deep enough, and that great underground lakes exist.

"Although the depth to which water penetrates in large quantities is much less than is frequently assumed, the ground contains an enormous amount of water. Many estimates of the amount of ground water have been made, all of which take into account only the free water (that which is, or might be available for pumping purposes) and do not include that which is contained in moist clays and other materials, and is not readily yielded to wells. These estimates have become more and more moderate, ranging from that of Delesse made about 1860, which showed a layer sufficient to cover the surface of the globe 7,500 ft. deep, through that of Slichter (1902) which showed a similar layer 3000 to 3500 ft. deep and of Chamberlain and Salisbury (1904) which gave a layer 800 to 1600 ft. thick, to that of Fuller (1906) which shows that the amount of water available in the earth's crust is sufficient to form a layer over the surface of the globe, a little less than 100 ft. deep. This amount is equal to about one hundredth part of the volume of oceanic water."

The various types of wells commonly used in railway water service are: Hydraulic rotary wells, Standard drilled wells, Jetted wells, Bored wells, Driven wells, Open wells.

The hydraulic rotary process consists of rotating downward a string of casing with a toothed cutting shoe on the lower end. The weight of the casing on the shoe grinds and cuts away the material that is being penetrated, and the particles are carried to the surface by the water which is pumped through the casing and rises on the outside between the casing and the wall of the well. This method of drilling is very rapid in soft materials, and can be adapted readily to alternate beds of hard and soft material, the harder materials being penetrated by a drill. The process is, however, very satisfactory where the soft materials predominate, and in such materials the operation is practically continuous.

The disadvantage of hydraulic rotary drilling is that a large quantity of water is required, the amount depending on the porosity of the materials encountered. There is also danger of passing through water-bearing stratum without recognizing the presence of water, especially when mud laden fluid is used. The records of rotated wells are always more or less inaccurate owing to the difficulty of recognizing the different formations as soon as they are entered.

Standard Drilled Wells

The standard method of drilling wells probably originated with the churn drill used in China centuries ago. This method is used only when penetrating rock or other hard material and consists of raising and dropping a heavy drill against the rock. The drill is rotated by hand for the first 200 ft. or so to insure a round hole, after which the wind or twist of the cable changes the position of the drill automatically with each stroke. The cuttings of the drill are removed by means of a sand bucket which is constructed with a valve in the bottom which opens as the bucket is lowered, and closes as it is raised. Standard drilling is not continuous as with rotary drilling, as the string of tools has to be removed frequently to clean out the hole and change bits. It is costly and requires an expensive outfit as many difficulties are encountered in deep drilling. The string of tools is frequently lost and it

is necessary to maintain an outfit of fishing equipment to recover lost tools, the fishing operations in many wells taking more time and causing more expense than the actual drilling. The advantages are that it is adapted to drilling in all kinds of rock, is not limited to any ordinary depth, a good record of strata and water beds may be kept and all satisfactory water bearing strata may be utilized.

Jetting Wells

The jetting process for the sinking of wells might be called a combination of the standard drilling and hydraulic rotary processes, in a modified form. The jet consists of a drill on the lower end of the pipe with openings to allow the water to escape. The drill loosens the consolidated materials and the water washes the cuttings out of the hole. As with the rotary process jetting can only be done in soft material. Jetted wells are limited in size and can be sunk only to a moderate depth. The method is very rapid in soft materials and is much cheaper than the rotary and other drilling methods.

Bored Wells

Bored wells are from 12 in. to 3 ft. in diameter and are sunk with an earth auger turned by hand or by horse power. The auger is lowered into the hole and turned around until filled with material when it is raised by a windlass or block and fall and emptied. The well is usually cased with wood or tile. This type of well is limited to a depth of 40 or 50 ft. in most localities and as a result is dependent on the strata lying near the surface and seep water. Such a well is subject to contamination, stagnation and frequent failure during drouth.

Its advantages are that it is constructed cheaply by unskilled labor and with very little expense for tools or curbing.

Driven Wells

Driven wells are of two types. The first, and most common type is made by driving a strainer and drive point down to the water bearing stratum. The water level in a well of this type must be within 25 or 30 ft. of the surface as the drive pipe is too small to permit of lowering a cylinder to the water level. On larger driven wells the casing is fitted with a drive shoe and is driven down to the required depth, the strainer placed in position and the casing pulled back until the strainer is exposed to the sand. In driving the pipe the material is kept out of it with a sand bucket.

Open Wells

An open well is merely a matter of excavation and curbing. It can only be sunk to a comparatively slight depth except at a very heavy expense. The supply is limited to seep water and such sources as lie near the surface. The well requires frequent cleaning, and can not be depended on during periods of drouth.

The cost of drilling wells varies with the size, depth, kind of well, material, etc., to such an extent that no figures on cost may be given that would be of any particular value. As an illustration of the difference in cost of drilling under varying conditions, a number of deep borings are given, together with the cost. These borings include the deepest wells in the world.

1. Coalings, California. Well 2,890 ft. deep. The well was carried 20 in. in diameter for 2,000 ft., followed by 12 in. and finished 10 in. The drilling operations extended over a period of 9 years, and the cost is said to have exceeded $150,000.

2. Two and one-half miles west of West Elizabeth, Pa. Well 5,575 ft. deep, from 10 in. to 6¼ in. in size, cost $40,000.

3. Six miles west of Los Angeles, California. Well 5,660 ft. deep, from 16 in. to 4¼ in. in size. Cost approximately $100,000.

4. Schladeback, near Leipsic, Germany. Well 5,735 ft. deep, from 11 in. to 1.3 in. in diameter. Cost $53,076.

5. East of Rybuick, Upper Silesia, Germany. Well 6,572 ft. deep, from 3.6 in. to 2.7 in., cost $18,241.

6. Czuchow, Silesia, 7,347 ft. deep. This hole cost $80,082 and was given (1913) as the deepest borehole in the world.

(1-3-5, Oil City Derrick)

(2-4-6, U. S. Geological Survey)

C. R. KNOWLES,
Chairman.

WOODEN TANKS

By C. R. Knowles, Superintendent Water Service, Illinois Central Railroad

While discussions of steel and concrete tanks occupy a place in the great mass of engineering literature, it is surprising to note that but little has been written on the subject of wooden tanks, notwithstanding the fact that the wooden tank antedates both the steel and the concrete tank by many years. It is apparent that wooden tanks have been neglected by writers on engineering subjects except to the extent of publishing certain specifications and designs. The subject appears to be a timely one in view of the present steel situation and the fact that the concrete tank has not been developed to such an extent that it can replace either steel or wood entirely in tank construction.

Within the past few years steel tank construction had reached a point where it had largely supplanted the wooden tank on railroads on account of the low cost of production, improvements in design and the increasing scarcity of suitable timber. The unprecedented conditions growing out of the world war have resulted in greatly increasing the cost of steel tanks and this increased cost and the uncertainty of delivery have compelled many railroads to again give consideration to wooden tanks. Although conditions relative to the available material for wooden tanks have not improved there seems to be sufficient material to supply the demand and while the price has shown an increase in cost it has not kept pace with the cost of steel plates. A surprising feature of the situation has been the fact that the manufacturers of wooden tanks do not appear to be alive to the situation and the opportunity to push their product. In spite of this apparent apathy on the part of the wooden tank manufacturers there has been a decided increase in wooden tank construction on railroads which has been further augmented by the ruling of the Railroad Administration prohibiting the use of steel plates for the construction of water or oil tanks, except in high tanks where steel is essential.

The wisdom and necessity for such a ruling is at once apparent to all who realize the present shortage and need of steel in carrying on the war, yet the railroads generally do not seem to be aware of that fact as is shown by a circular from the Southern Regional Director dated Sept. 16 quoting a letter from the Priorities Committee of the War Industries Board to the Central Advisory Purchasing Committee stating that applications from contractors for priority on steel intended for the construction of railroad water tanks have been declined and that "It is to be regretted that the railroad companies generally have not yet realized the shortage of steel." The letter further states that manufacturing concerns are being required to use wood or concrete, not only for water but for the storage of fuel oil. The circular adds that all concerned should understand that applications will not be approved by the Priorities Committee for the construction of steel water and oil tanks and that the construction of such tanks must be confined at present to wood and concrete. That there is some question as to the suitability of concrete for the construction of water tanks generally is shown by a letter from the Northwestern Regional Director to the Northwestern railroads requesting information relative to concrete tanks. The letter requests specific information as to the length of service, and condition of tanks, and details of maintenance and cost, if any. It also calls for information as to the effect of climatic conditions on tanks now in use, admonishes the railroads to "Bear in mind particularly

the effect of freezing temperatures," and closes with a request for the recommendations of the railroads as to the use of concrete for the construction of water tanks.

The increased activity in the construction of wooden tanks, together with the growing demand in other lines for timber formerly used in tank construction naturally resulted in greatly increased costs and scarcity of suitable tank timber, especially for the larger sizes of tanks. The result has been that cheaper timber of shorter life is being used and the standards of wooden tank construction have been materially lowered. The solution of the problem appears to be the use of treated timber for the construction of tanks where suitable timber is not available; at least until the present world war is brought to a conclusion.

Timber Suitable for Tanks

The subject of timber suitable for wooden tanks will be dealt with lightly here as the committee report on railway water tanks in the 1915 proceedings of the Association goes into the question of tank timber extensively and but little can be added at this time. At the time the 1915 report was written cypress predominated as a tank material, while at the present time redwood probably predominates with Douglas fir a close second, although cypress is still being used to a large extent, but at a greatly increased cost. Heart red cypress, of course, leads all available timbers in tank construction for long life although the scarcity of this admirable timber is growing more apparent year by year. Redwood is beyond a doubt second only in permanency to cypress; in fact many engineers on the Pacific coast maintain that redwood is as durable as cypress for tank construction and point to redwood tanks 40 years old and still in service as verification of their claims. Douglas fir and southern heart pine are about of equal value as tank material with a life of approximately 10 years.

Development of Construction

Wooden tanks are generally built circular in form as this shape is more simple and economical in construction than any other form, the simplicity and economy being chiefly in the reinforcing required. A rectangular tank would probably not require any more framing than a circular tank, but would require a great deal more reinforcing than a circular tank of the same capacity, although many rectangular tanks have been built.

The Philadelphia & Reading at one time adopted as its standard, a rectangular or box tank, 15 ft. wide, 29 ft. long and 8 ft. deep inside measurements. The capacity was 26,000 gal. The advantage claimed for this style of tank was that it was cheaper to build than the circular tank and did not require as high a class of labor for erection. While this may have been true a few years ago when labor, lumber and iron were cheap, the opposite is the case today and square tanks are rarely constructed except in small sizes for emergency stations where material is not available for the construction of circular tanks.

There has been but little change in the design of circular wooden tanks since their first construction, as it is obvious that this type of tank will permit of but slight modifications, although there has been a wide variation in size, the capacity increasing with the greater demand for water and the necessity for additional storage. The only marked change in wooden tank construction from the earliest form to the present type has been that of eliminating the taper of the staves. Up to within a very few years ago all wooden tanks were constructed with tapering staves, making the tank smaller at the top than at the bottom. the original reason for this being that the hoops were not provided with lugs and bolts, but were riveted to the required diameter and driven down on the taper of the tank until they were tight as in driving a hoop on a

barrel. The sectional hoop with lugs and bolts replaced the solid hoop as it was found more satisfactory, especially for the larger tanks. The sectional hoop eliminated the necessity for tapering tanks, and the great majority are now built with the top and bottom of the same diameter, although a few roads have clung to the taper tank, probably from force of habit.

There have, of course, been certain modifications in the design of staves, hoops, etc., that have not materially changed the design of the tank. One of these is a non-shrinking stave, being made with a deep channel or groove in the top. This groove is filled with water from the pump discharge, which passes into the pores of the wood, keeping the top of the staves moist even when the tank is only partly filled and preventing shrinkage.

Sizes of Tanks

Wooden tanks are commonly constructed in practically all sizes up to 30 ft. in diameter and 20 ft. staves, and in some few instances in larger sizes. A 20 ft. by 30 ft. tank with a capacity of 100,000 gal. would appear to be the economical limit. If it is desired to build a wooden tank of greater capacity than 100,000 gal. the increased capacity should be gained by increasing the height of staves rather than the diameter of the tank. The longer stave would require more hoops and closer spacing, while an increased diameter would require thicker staves and bottom plank to maintain the required factor of safety, and if a much greater diameter were obtained bracing of the staves would be required to preserve the circular shape of the tank, as the pull of the hoops has a tendency to flatten the walls and throw the tub out of shape. Also the additional load would require a stronger tower. The additional cost of storage per thousand gallons would probably be more than if two or more tanks were constructed. Therefore, it is generally conceded that the construction of units within a capacity of 100,000 gal. represents the most economical construction. There is also a certain advantage in having two or more tanks as one tank may be taken out of service while being cleaned or repaired, without interruption to service.

Decay of Tanks

When the fibres of the wood comprising a tank are thoroughly saturated with water, decay is practically impossible; on the other hand if the wood was perfectly dry there would be little likelihood of decay. In water tanks, however, there is always an intermediate condition of moisture in which the wood is dry on the outside and wet on the inside, thus promoting rapid decay unless the timber has been carefully selected and has a relatively long life.

It is difficult to point out any portion of the tank more susceptible to decay than another, although decay in the tops of the staves is more noticeable, and the timber probably decays more quickly here than in any other part of the tank. If this is true it is very likely caused by a wider variation in the degree of saturation owing to the tank being filled and emptied. One of the arguments put forth in favor of roofs on tanks is the protection given the tops of staves. The advantage of a roof in the prevention of decay in the staves is extremely doubtful, as the only function it can perform is to keep the staves dry, which is obviously impossible in a tank used for the storage of water. To repeat a former statement, the most effective method of preventing early decay in wooden tanks is the careful selection of timber having a relatively long life or treating the timber to prevent decay. Poor inspection of timber is responsible for much of the decay in wooden tanks. A few poor staves in a tank will cause trouble even if the remainder of the staves are perfect.

An interesting feature is brought in connection with a 16 ft. by 24 ft. white pine tank taken down after 30 years' service. It was necessary

to renew the entire tank, but it was found that the staves on the north side of the tank were in much worse condition than any of the rest; the reason for this is given that the north side was always shaded which allowed moss to accumulate and assist decay. Another instance is quoted where heart cypress with an ordinary life of over 30 years failed from decay in 15 years owing to water shortage causing the tank to remain dry at periods several times each year.

Creosoted Water Tanks

The Illinois Central has recently started to use creosoted timber in the construction of its standard wooden water tanks. Nine of these tanks constructed during the past year proved so successful that this road is now building more and has practically made the creosoted tank its standard. Creosoted tanks were resorted to on account of the high price and great demand for steel for other purposes than tank construction, and the scarcity and cost of timber that would be suitable for use without treatment.

Although there are many different timbers commonly used in the construction of water tanks, there are but few available in suitable sizes and lengths to be used in the construction of large tanks, and when the life of the timber is considered this list may possibly be reduced to two,—cypress and redwood. The great demand for these timbers has been such that the price has advanced rapidly and suitable lengths are difficult to obtain. Undoubtedly the timber situation will grow worse as the war continues. Thus the use of lower grade timber that will take treatment readily appears to be a timely move.

The creosoted tanks built by the Illinois Central are of their standard sizes, of 100,000 gal. capacity with a 20 ft. stave and 30 ft. bottom, and 50,000 gal. capacity having a 16 ft. stave and a 24 ft. bottom, no change having been made in the plans formerly used for the construction of untreated wood tanks. The timber used is loblolly pine, coming under the general specifications for tank timber except that no restrictions are made as to heart or sap. The timber is air seasoned and should be permitted to season for three months in favorable weather. The method of treatment employed is the Rueping process, using about 5 lb. of oil per cu. ft. of timber. The oil used is a coal tar creosote, coming within American Railway Engineering Association No. 1 Specifications. The tank towers, constructed of 12 in. by 12 in. posts and 6 in. by 8 in. braces. roof, frost box, ladder and all timber entering into the complete structure is creosoted.

A very important feature in the construction of these tanks is that all timber more than 1 in. in thickness is framed before treatment, to secure the maximum life from the treated timber. The work of framing the tank before treatment is given such careful attention that it is rarely necessary even to bore a hole in the treated timber during the field erection of the tank. The work of framing and treating is done by company forces at the Grenada, Mississippi, creosoting plant. The tanks are erected by line gangs. Thus, in the manufacture and erection of these tanks the Illinois Central is independent of outside forces except the mills which cut the timber and ship it to Grenada in the rough.

When one discusses creosoted tanks for the storage of water the question is immediately raised as to the effect of the creosote on the water. In the tanks construction on the Illinois Central the presence of creosote in the water has been so slight as to be hardly noticeable and it has had no detrimental effect whatever upon the water. The Bureau of Industrial Research of the University of Washington conducted extensive tests of creosote wood stave pipe to determine its effect upon water for domestic and irrigation purposes. The test was conducted to determine the effect upon water carried by a 56-in. creosoted wood stave pipe line 22½ miles long, from the Landsberg intake

on the Cedar river to the Volunteer Park reservoir in the City of Seattle. In conducting the experiment a smaller pipe was used but care was exercised to have the conditions in the experiment representative of those existing in the larger pipe lines. The conclusions of the Bureau were that there was no detrimental effect of the creosote on the water. These conclusions were borne out fully by the results on the Illinois Central and the creosoted tank has proven an unqualified success.

Frost Proofing

A wooden tank is in itself a certain protection against frost. No frost proofing is required for the tank proper throughout the greater portion of the country and in few cases is any required even where the most severe cold weather prevails, providing the consumption of water each 24 hrs. equals the capacity of the tank. This, of course, applies only to the tank, as the inlet and outlet pipes will have to be protected against frost where a freezing temperature exists. The most effective frost box is one constructed with one or more air spaces. The walls should be of dressed and matched lumber and lined with building paper to make them as air tight as possible. More frost protection is always required where surface water is used than with water from wells as the temperature of well water is usually above 50 deg. F., while the temperature of surface water is often only slightly above the freezing point.

No set rules may be applied to frost protection as weather and other conditions vary so widely throughout the country that uniform practice is out of the question. The factors governing are: (1) Source of supply and initial temperature of water. (2) Minimum temperature prevailing and duration of temperature below freezing, always remembering that a temperature of 20 degs below zero maintained for two weeks offers a far more serious problem in frost proofing than 40 deg. below for two days. (3) Size of inlet and outlet pipes, and whether flow of water is continuous or intermittent. (4) Consumption of water in relation to the storage capacity of tank. Wherever possible artificial heat should be dispensed with as stoves are responsible for more than 50 per cent of the tank losses from fire.

Fire Risk

While a wooden tank may be destroyed by fire as readily as any other frame structure when exposed to a fire hazard it is not the great fire risk that it is popularly supposed to be. An analysis of the tank fires occurring over a period of ten years on a railroad having 341 wooden tanks in service is as follows:

Number of wooden tanks	341
Insurable value	$591,517.00
Average insurable value per tank ..	1,734.60
Total fire loss ten years	22,635.52
Average loss per tank, per year	6.64
Percent loss to total value	.38

During this period there occurred 17 tank fires, 10 of which resulted in the total loss of the tank or an average of one each year which would indicate that the chances of a tank being destroyed by fire are in a ratio of about 1 to 350.

While the record of tank fires given above is not one to be proud of it is probably representative of the railroads of the country although it is expected that the loss can be kept well below the above figures by making a careful analysis of the causes and applying preventive measures.

Analysis of the causes of the fires is as follows:

6 fires caused from	thawing pipes	Total	loss	$11,780
3 " " "	overheated stoves	"	"	4,850
3 " " "	sparks	"	"	2,775
1 " " "	cleaning lamps	"	"	1,700
1 " " "	tramps	"	"	1,500
2 " " "	foreign exposure	"	"	29
			Total	$22,635

It will be noted that 52 per cent of the losses were caused from thawing frozen pipes, 21 per cent from overheated stoves used to keep the tanks and pipes from freezing and 8 per cent from cleaning lamps under the tanks, or a total of 81 per cent of the losses may be charged directly to carelessness. If we include the fire caused by tramps we have a loss of $19,830 or 88 per cent of the total in ten years for which no reasonable excuse may be offered. It is interesting to note that 13 of the fires occurred during the winter months, 4 in November, 3 in December and 6 in January, with a loss of $19,830, or nearly nine tenths of the total, indicating that the danger from fire is almost wholly confined to the winter months and that protection from frost is also a protection against fire.

Life of Wooden Tanks

A letter of inquiry requesting information as to the life of wooden tanks was sent to 45 railroads and 27 answers were received. While much valuable information was obtained from the replies to the letters, the figures and estimates given as to the life of tanks were almost as many as the replies received. It should not be assumed that the figures given for the life of tanks were incorrect as the information submitted was undoubtedly as accurate as it was possible to give.

The variation in the figures submitted on the life of timber on various railroads goes to show that no accurate estimate may be made on the life of tank timber that will apply to all sections of the country. It is characteristic of timber that it is more durable when used in the region in which it is grown than when used elsewhere, for nature seems to have fortified the timber against decay to a certain extent when it is kept in its native climate.

One railroad reports 77 redwood tanks in service in California ranging from 26 to 48 years old, while another road reports redwood tanks renewed in Wisconsin after only 15 years of service. Twelve white pine are reported in service in Michigan with an average life of 35.4 years, while it has been necessary to replace white pine tanks in Missouri after 12 to 13 years. A Texas road reports cypress tanks in service as follows:

5	tanks	31	years	old
8	"	30	"	"
3	"	29	"	"

while several eastern roads fix the maximum life of cypress at 25 years.

A tabulation is submitted herewith showing the life of 310 tanks, 184 of which are still in service and 126 of which have been relieved. In preparing this tabulation only figures were used where the definite life of the tank was given. The lack of definite information as to the life of tanks as given in these letters shows the necessity of keeping more accurate records of the tanks in service than has been the practice in the past. The tabulation is as follows:

AVERAGE LIFE OF 184 TANKS IN SERVICE

Redwood

Railroad	"A"	77 tanks	Average life	32.6 years

Cypress

Railroad	"B"	29 tanks	Average life	28.3 years
"	"C"	25 "	" "	25 "
"	"D"	3 "	" "	32 "

White Pine

Railroad	"A"	24 tanks	Average life	29.7 years
"	"E"	12 "	" "	35.4 "
"	"F"	4 "	" "	29 "
Seven Railroads		184 tanks	Average life	30 years

AVERAGE LIFE OF 106 TANKS RELIEVED

Cypress

Railroad	"B"	24 tanks	Average life	27.3 years
"	"G"	16 "	" "	30 "
"	"D"	3 "	" "	32 "
		43		29 "

White Pine

Railroad	"H"	27 tanks	Average life	27.5 years
"	"B"	22 "	" "	25.8 "
"	"I"	14 "	" "	23 "
"	"F"	4 "	" "	29 "
"	"D"	3 "	" "	33 "
"	"E"	3 "	" "	38.3 "
"	"C"	5 "	" "	27 "
		78	Average life	27 "

(See further reference in second paragraph following)

Yellow Poplar

Railroad	"C"	3 tanks	Average life	30 years

Red Cedar

Railroad	"C"	1 tank	Average life	28 years

Yellow Pine

Railroad	"C"	1 tank	Average life	29 years
Eight Railroads		126 tanks	Average life	28 years

Summary

It will be noted that the white pine tanks show a higher average life than the cypress tanks in the table of tanks still in service while the opposite is true in the table of tanks relieved. This may be explained by the fact that cypress tanks were not used as extensively as white pine tanks up to 20 years or so ago, and on the roads shown there are

probably many white pine tanks which were in use before cypress tanks were constructed, although there is apparently very little difference in the durability of the two woods.

It is interesting to note that a yellow pine tank is shown with a life of 29 years while the life of a yellow pine tank as constructed today would probably not exceed 12 years. This difference in life can probably be explained in the fact that the trees from which the tank mentioned was cut had not been bled of the rosin and preservative oils natural to the wood. It should be explained that the life of 28 years given the red cedar tank did not represent the extreme life of the timber as when the tank was taken down the best of the timber was used in the construction of a smaller tank which is still in use. The original tank was constructed in 1870 which makes the timber in the smaller tank 48 years old.

In the letters received many records were given showing a life of only 10 to 15 years for cypress, white pine and redwood tanks. This was unfair to the timbers mentioned as the short life obtained was undoubtedly due to poor selection of timber, poor construction, the tank not being kept filled with water or some one or more of a number of faults that would cause early decay.

Hoops

A very complete report on tank hoops will be found in the proceedings of the Association for 1910 and little may be added at this time except to offer a suggestion that consideration be given to the standardization of tank hoops. Tank hoops in general use are principally confined to four different shapes,—round, half round, oval and flat. Even when a road adopts a certain shaped hoop it may not be of the same dimensions as the hoop used on another road. It would appear that flat hoops would be fairly uniform in dimensions but there is probably more variation in flat hoops than any other shape. In thickness they range from 1/8 in. to 3/8 in. and in width from 3 to 6 in. Some roads use a uniform thickness with a varying width; on others the hoop is uniform in width with a varying thickness while still others use varying widths and thicknesses and to make matters worse there is much variation in the spacing and length of sections.

There are many reasons why the standardization of tank hoops would be advantageous, chief of which is the conservation of steel; not that the standard hoop would require less steel to maintain the required fibre stress on the hoop but that it would allow the manufacturers to carry less stock to fill orders. On a recent visit to the plant of a large tank manufacturer it was found that he had on hand material to supply hoops for perhaps 30 or 40 tanks representing a dozen different hoop standards yet he could not ship two sets that were badly needed until steel was received from the mill to make up the particular type of hoop required. The standardization of tank hoops should have a tendency to lower the cost of manufacture and insure better deliveries and would, no doubt, result in a better and more uniform quality of material. It would appear that there is every reason why tank hoops should be made standard and no good reason why they should not be.

DISCUSSION

(Wooden Tanks.)

H. von Schrenk:—I don't think this report should be passed without a word of commendation on the work of the author. I think Mr. Knowles ought to be complimented on the very able and exhaustive manner in which he has dealt with the subject. I

would like to ask him if he knows of any other road than the Illinois Central which has tried creosoted material for tanks?

C. R. Knowles:—I understand the Louisvillė & Nashville built some a few years ago. The Big Four has built quite a number on steel towers within the last year or so. I think the Illinois Central is the first road to adopt the use of the complete creosoted structure. Our tanks are creosoted from top to bottom.

Question:—Does it affect the water for drinking purposes?

C. R. Knowles:—The creosote has no effect on the water that is noticeable except a slight taste at first, but is not absolutely harmful. The pipe line mentioned in the report as supplying water to the city of Seattle carries drinking water. The authorities had exhaustive tests made to determine the effect of the creosote and after the 18th day of the use of the pipe line there was no taste of creosote that could be detected.

Question:—What season of the year were the Illinois Central tanks erected, and if the work was done during warm weather what effect had the creosote on the eyes and faces of the men assembling the material?

C. R. Knowles:—Each man might give a different answer to that. We have erected some in the winter time which is preferable because the timber is easier handled than in warm weather, but we were erecting them all through last summer and I have heard of no objections on the part of the men engaged on the work. In fact we have been putting up creosoted towers for the past 18 or 20 years and I cannot recall any serious objections or complaint where any of the men became injured or even affected in any way by the creosote.

P. J. O'Neill:—I erected a white pine tank of 36 ft. diameter holding 125,000 gal. in 1895. After we gave it a thoro coating of carbolineum we found it had a very disastrous effect on the men and that wherever the skin was exposed it was worse than sunburn. Perhaps the men, when erecting the tub of a tank, come in closer contact with the material they handle than they do when erecting a tower. But the carbolineum certainly preserved that tank. It is as good today as ever. At the time we erected that tank we connected it with an 8 in. pipe to supply a standpipe. Later we ran a 12 in. pipe for this connection and cut another hole through the bottom of the tub. I kept the piece that was sawed out after it had been in service about 20 years and it was apparently just as sound as the day it was first put into

use. There was not the slightest indication of decay. The timber used in this tank was selected white pine and had no sap. Wherever white pine tanks have failed I think it has been due to sappy material. In later years when we used white pine for tubs I found it was difficult to get planks that one could use without losing 20 to 30 per cent on account of removing sappy material but I thought it paid even to do that. Once in a while a stave will get in which has some sap and it was found that it had to be patched before many years.

J. P. Wood:—The material which Mr. Knowles used probably had been treated with about 5 lb. of creosote per cu. ft. Had his men been using timber that had 12 to 15 lb. per ft., as is used for standard bridge work, his men probably would have made some complaints.

The Secretary:—The treatment of the material used for tanks and pipe lines is probably not so heavy as that used in bridge work and for other purposes, but even if it were it can be handled by the men without injury from the treatment if properly done and at the right time, provided the necessary precautions are taken. It is perhaps not advisable to use creosoted material or that coated with carbolineum soon after the treatment has been applied or under certain atmospheric conditions. Some degree of judgment must be applied in such cases, the same as in connection with anything else. The creosoting of material has come to stay, for some time to come at least, and we must learn how to work with it.

H. von Schrenk:—There has been a good deal of complaint from time to time as to the injuries received by workmen as a result of working with creosoted material. We have had a number of lawsuits connected with that problem and I found that the injury complained of was confined principally to light-skinned and fair-haired people. Swedes are more affected than the so-called Americans with dark skin and dark hair. In the south the negro is never influenced by it at all but a man with light skin is liable to have his hands and face blistered if he is not careful.

It was found to be the best preventive to have the foreman advise the men to cover their hands and face with a kind of oil or vaseline before they went to work; nine times out of ten they then suffer practically no effect whatever.

The degree of injury depends somewhat on the kind of treatment which is used. The creosote used years ago had a very much more active effect than that used at the present time be-

cause the oil was so much heavier. I don't think the injury usually is anywhere nearly as much as one is led to believe by some reports. I have personally traced down a great many such reports and often the injury is due to something else. It looks like a severe case of poison ivy. The application of oil is a good remedy.

E. E. Clothier:—My experience has been that my men have suffered as much on the unexposed parts of their body where the creosote seemed to penetrate their clothes as on their hands and faces, and it came to a point where they almost refused to work on account of the effects of the creosote. I never noticed the difference resulting between light and dark complected people.

C. R. Knowles:—It seems to me that some time ago a lawsuit on the Louisville & Nashville was brought by someone who claimed that he had been injured by creosoted timber and that the defense demonstrated its case by one of the parties washing his face and hands in a basin of creosote oil in the courtroom.

H. von Schrenk:—I do not know of that particular case, but I did that very thing myself and it did not harm me in the slightest degree,—although a great many people are affected by it. However, most of the lawsuits are fictitious—like the famous story of the jersey cow.

In another case two hours were spent in reading the dangers of creosote and then I was asked to agree to the correctness of the statements, to which I fully agreed. But this was a chemical compound of creosote condensed for medical purposes. That, however, has no connection with creosote oil in common use.

C. R. Knowles:—There is no question but that the most important feature in connection with the construction of non-treated wooden tanks is the selection of the material; and the premature failure of wooden tanks, I believe, can be traced almost entirely to the poor selection of material where a durable long-lifed timber has been used. I recall an incident of a few years ago where we moved three cypress tanks. Our standard up to within the last 10 years was an 18 ft. by 30 ft. tank. We moved three of these, one of which was constructed in 1904, another in 1909, and the third in 1911. The first of these was in better condition than either of the other two, and I think that we renewed three staves in it when we rebuilt it. We renewed something like 14 staves on one of the other tanks and 20 to 30 on the third. These were reconstructed after being in service from 6 to 10 years and were

better then than before on account of culling out the poor material that crept in in the first place.

W. E. Alexander:—I am interested in this talk on wooden tanks. We are in a cold climate and have nothing except wooden tanks on our road (the Bangor & Aroostook). We have tanks ranging in size from 10,000 gal. to 100,000 gal. capacity. We have some tanks that were built as far back as 1892 and some of them are still in service. They were furnished by Fairbanks, Morse & Co., and were built of Michigan pine. They have the original hoops, but some of the later tanks have hoops that last but a short time. We had one tank which was erected on a 50 ft. tower where the hoops rusted off and fell to the ground twice in three years. Where the modern hoops are likely to give out we place round hoops between the flat ones as a matter of safety.

In our country one cannot build tanks that are secure from frost. We usually enclose the space beneath the tank and provide a stove with a cast iron pipe extending up through the tank which prevents freezing. Some of the tanks are provided with oil heaters. We tried tanks built in the ordinary way with the standard frostproof boxes but we had to resort to the heaters. It is a serious problem with us when the temperature gets from 35 to 40 deg., and more, below zero, especially where we do not pump from wells and where we do not use a great deal of water. Wherever we have steam pumps we also run the exhaust steam into the water going into the tank which helps a great deal.

We have never lost a tank from heating by stoves and oil heaters.

J. P. Wood:—Where a tank is emptied once in 24 hr., even in our cold climate in Michigan, it does not require any extra precautions beyond the standard frost-proofing, except that one should see to it that water is properly drained in the vicinity of the frost box. This year I have been equipping frost boxes and stand pipe pits with a steam coil direct from the pump boiler. Of course, where we have only gasoline or kerosene engines we are not able to do that.

I have one plant where the piping is protected with asbestos covering. We have yet to ascertain just what success we will have with that. It has been in service a couple of years and so far we have had no trouble. Just now we are using a frost box with two air chambers just large enough to contain the pipe

and the pipe covering. The frost box is only about 12 in. in diameter over all.

P. J. O'Neill:—We have a great many wooden tanks but I have no fear from frost. Last winter when it got down from 10 to 20 deg. below zero we experienced no frost trouble. I do not mind the freezing of the ice on the inside of the staves. Let it freeze; it is a protection after it becomes 15 to 18 in. thick. We put a 12 in. extension on the outlets in the bottom of the tanks to allow for freezing.

We construct a brick frostproof box just inside of the four center posts, built of two brick walls with a 4 in. space between. We have a concrete pit in the bottom in which a fire may be built if the temperature gets below zero. There is no danger, for the fire is 25 to 30 ft. below the bottom of the tank. That keeps the frost box warm all the way up. The bricks get warm and I dare say that 24 hr. to a week after it will not freeze in that frost box.

C. R. Knowles:—Two air spaces are not enough in this climate where building paper and lumber is used for the frost box. Brick is much better. In addition to being a better frost protection it is also fireproof. Where we use lumber we make four air spaces on the northern territory occupied by our road. That part of the frost box beneath the ground is built of concrete with a 12 in. wall. The central air space extends below the frost line and there is no trouble with freezing of the inlet pipes because of the benefit of the warmth from the earth below. It gets pretty cold in Iowa and Minnesota. The winter of 1911 and 1912 I don't believe it was warmer than 20 deg. below zero at any time from the middle of January to the middle of February, but we had very little trouble with outlet pipes freezing. I think a great deal of the trouble, where it exists, results through carelessness in allowing the outlet valve to leak, but where it is kept tight and where the tank is filled and emptied daily there should be little or no trouble in this latitude with wooden tanks. We use stoves in a good many of our tanks west of here but they are mostly on branch lines where we have but one or two trains per day and a tank of water may last perhaps a week. However, I really think that the majority of the stoves are used largely as a force of habit.

E. E. Clothier:—We (C. M. & St. P.) have four air spaces in the frost box. The inner space is large enough to accommodate a car heater. The temperature in our country west of Mobridge

gets as low as 42 deg. below. I have had tank valves become clogged with ice when the water would escape in sufficient quantity to freeze the train to the track opposite the tank. At each tank we have a hose that can be connected with the locomotive to be used in thawing ice in and about tanks.

C. R. Knowles:—It is true that trouble is often caused in tanks from ice breaking loose during thawing weather, getting under the valves, etc. Then again, while an engine is taking water ice may form in needles and sometimes freeze the valve to the seat.

F. M. Case:—I would like to ask Mr. Knowles as to the thickness of the staves and bottom of the Illinois Central tanks?

C. R. Knowles:—Our tubs are built of 3 in. material throughout.

F. M. Case:—Some roads use 4 in. material. What is your opinion of the difference in the lasting qualities of the 3 in. and 4 in. material?

C. R. Knowles:—I cannot say, but I think the same theory would apply as with the wood stave pipe lines. If you exceed a thickness of 3 in. in tank material you are going beyond the limit of saturation; in other words the inner portion is saturated and the outside shell is dry, which promotes decay. Therefore I should think a 3 in. thickness is preferable.

A. S. Markley:—We do not use stoves and as a result we have some freeze-ups. There is a difference where the water is supplied to a locomotive from a tank or from a stand pipe. One is liable to have trouble in taking water direct from a tank if a leaky valve exists. We have pine tanks in service since 1888 which are in good condition yet. We have red cypress tanks built in 1881 which are still good. We have fir tanks that were built in 1884 one or two of which have been renewed while we will have to renew several more in the next few years.

P. J. O'Neill:—Our water tanks are tapered. I do not like a tank with parallel staves. With the latter if the tank shrinks a little the hoop will fall, while on a tapering tank it simply drops down a little and tightens itself.

J. P. Wood:—I am becoming disgusted with steel hoops as I presume every other man is who has had experience with them. Hoops that were put on tanks 30 or 40 years ago, made of wrought iron, are still good, while the average life we get out of the modern steel hoop is from 6 to 10 years.

BRIDGE DECKS AND GUARDS

COMMITTEE REPORT

The committee received replies from 25 railroads in response to a circular letter sent out soliciting prints of standard practice with reference to bridge decks, ties and their spacing, inner and outer guard rails, etc. All but 7 responded to the inquiry for information wanted although some of the roads sent only partial data as to bridge decks.

A tabulation for open floor decks for typical steel bridge spans has been compiled in Plate 1 from the various replies received, which it is hoped will be of interest as showing current practice among most of the larger railroads. The committee was impressed with the practical agreement as to the use of T-rails for inner guards. Generally second hand and scrap rails removed from running tracks or from stock are used. An old frog point, or a point casting, is used where facing the traffic and in a few cases also where trailing the traffic. Plate 2 illustrates the use of the inner guard of T-rail section in connection with a second-hand or remodeled frog point. Plate 3 shows a type of point casting used by some of the railroads. Points are of course used at each end of a single track bridge, the distance from bridge ends varying from 30 ft. to 90 ft. The distance between the heads of running rails and guard rails is found to vary between 8 and 10 in. However, 8 in. and 9 in. spacings predominate. It is not clear in some cases whether the inner guard rail is spiked to every tie or every other tie. Plate 2 shows the inner guard rail spiked to every other tie throughout the length of the bridge. Plate 4 shows the Pennsylvania railroad standards for bridge guards.

The decks of timber bridges need not be fully discussed in this report as they have been covered previously in volume 25, page 71 of our proceedings. It is noted however in the replies received that 8 in. by 8 in. ties, 10 to 12 ft. long seem to be the most popular for decks of timber trestles, with 6 in. by 8 in. outer guard timbers generally in use.

The fire proofing of bridge decks has been also reported on in volume 21, page 47. There is apparently no change in this practice. Bridge number boards are generally attached to the bridge decks and our members are referred to volume 21, page 85 for a committee report on this practice. Also for the kinds of timber entering into timber trestles and in bridge decks one should refer to volume 19, page 175 of our proceedings.

Plate 5 shows the practice of the Rock Island lines with respect to ballasted floors for steel girder spans. A treated timber deck supports the ballast and track. We consider this good practice where treated timber is used in preference to reinforced concrete deck slabs. The matter of reinforced concrete decks in connection with ballast floors is a subject in itself and one should refer to volume 24, page 133 of our proceedings for a concise report on this practice.

Referring to the subject of the open floors in steel bridges, the general practice seems to be as follows: Every second or third tie is bolted to steel stringers or girders. Outer guard rails are generally bolted to every third or fourth tie by means of machine bolts or lag screws. Inner guard rails are usually spiked to every second tie, and in a number of cases to every tie.

The tabulation on Plate 1 shows the practice with reference to spacing ties and guard rails. Most of the replies received did not indicate whether tie plates were used under running rails on ties on bridges. We assume that railroads using tie plates under rails on ordinary ballasted tracks on roadway would likewise use them on

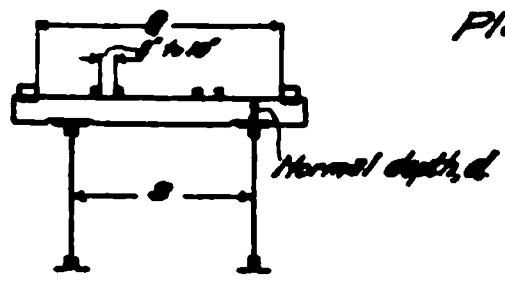
bridges. It is hoped that the use of tie plates will be fully brought out in the discussion of this report. One company reports the use of tie plates also under the inner guard rail.

It is suggested that railroads working up new standards of practice should be governed by the following principles, so far as steel spans are concerned: A constant distance should be maintained from center to center of stringers, and of girders up to considerable span length; no change in size of tie will then be found necessary. The width of deck and the distance "in to in" of outer guard rails may thus be kept uniform, which will give a good appearance, and also reduce the number of sizes of sheets of galvanized iron required to be held in stock where it is the practice to fireproof decks with sheet iron.

H. A. Gerst,
W. S. Bouton,
J. S. Huntoon,
W. A. Spell,
E. K. Barrett,
F. A. Benz,
W. L. Rohbock,
R. H. Reid,

Committee.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION.
Subject: Bridge Decks and Guards.
Plate 1.



For methods of taking care of Superelevation of rails, see Vol. 20, p. 99.

TYPICAL CROSS SECTION.

DIGEST OF CURRENT PRACTICE FOR OPEN FLOORS ON STEEL BRIDGES.

NAME OF RAILROAD	GENERAL DETAILS OF DECK.						GUARD RAILS		REMARKS
	SIZE OF TIE	d inches	s ft-in	g ft-in	Spacing of ties inches	TIE PLATES USED	INNER, KIND	OUTER; SIZE	
A.T.&S.F.	8"x8"-12'	7½	7-0	7-7	12	[illegible]	T-rail	6"x8"	Same size tie for several types of stiffs
B.&O.	8x8-9 Larger ties	7½ —	6-6 Var.	5-10½ —	14		T-rail	6x8	Main rail spiked every other tie, except on curves spiked every tie.
B.R.&P.	8x12-12	11½	8-0	10-8	14	Each tie, Main Line	T-rail	6x8	8x10-10 Ties used for spans less than 75'
"	8x10-10	9½	7-0	8-8	14		T-rail	6x8	See above.
C.&O.	8x10-10	9½	6-6	8-0	12		T-rail	7x8	Inner gd rail on all bridges
"	8x12-11	11½	8-0	9-0	12		T-rail	7x8	ditto
C.&N.W.	8x8-12	8	6-6	10-4	12	Generally on Curves		*10x12	*Bolted every tie
"	8x10-12	10	8-0	10-4	12	"		*10x12	" " "
C.B.&Q.	8x10-10	10	7-0				T-rail	6x8	
"	8x12-10	12	8-0				T-rail	6x8	
C.M.&St.P.	8x12-10	11½	7-6	Var.	12		4x8" Timber & 6x6x½ L.	5x8	Spacing blocks used between ties
"	8x12-12	11½	8-0	"	12		4x8 Timber & 6x6x½ L.	5x8	ditto
C.R.I.&P.	8x10-10	9½	7-0	8-7	12		T-rail	6x8	Main rails full spiked over entire bridge.
"	8x12-12	11½	8-0	10-0	12		T-rail	6x8	ditto
ERIE	8x8-9	7½	5-0	7-6	14			5x8	Hook bolts every 3rd tie in outer G.R.
"	8x12-10	11½	8-0	7-6	14			5x8	Lag screws " " " " " "
FLOR. E. COAST	8x10-10		7-6	7-0	16		T-rail	6x8	ditto
"	10x10-11		7-9	7-0	16		T-rail	6x8*	*6x6" tie spacing blocks used.
GR. TRUNK	10x10-13	9½	7-0	11-8	14		T-rail	8x8	For Branch Lines, 8x8-12' ties are used
GT. NORTHERN	8x12-12	11½	7-6	10-0	12	Each tie, Main Lines.	T-rail	6x8	No tie pls, and rails spiked every other tie, on Br. Lines, except as otherwise ordered.
ILL. CENTRAL	8x8-10	8	7-0	7-6	14		T-rail	6x8	
"	8x10-12	10	8-0	8-4	14		T-rail	6x8	
L.&N.	8x8-10	8	6-6	6-10	14		4x9" Timber	5x9	G.R. Fastened with lag screws. T-rail also used. Tie plated on curves.
"	8x11-13	10½	9-0	6-10	14		4x9" Timber	5x9	ditto
MICH. CENT.	8x10-12	7	6-6	10-8				6x8	Ties laid flat. Dado from special plan.
N.Y. CENT.	8x10-11	Var.	6-6	9-8	12		T-rail	5x8	
"	8x12-11	"	8-0	9-8	12		T-rail	6x8	
N.Y.N.H.&H.	8x8-11	7½	6-6	7-0	14		T-rail	6x8" Timber & 3x3x½ L	
"	8x12-11	11½	8-0	7-0	14		T-rail	6x8 Timber & 3x3x½ L	
PENN. LINES W.	8x8-9		6-6	7-0	14		T-rail	6x8	Inner gd rail braces every 3rd tie.
PENNSYLVANIA	10x9-9	9	6-6	6-10	16	Each tie	T-rail	6x8	10"x10½"-11' ties used where S=8'0"
UNION PACIFIC	8x10-10	9½	7-0	7-0	12	" "	T-rail	5x8	
"	8x12-12	11½	8-0	7-0	12	" "	T-rail	5x8	Also larger ties for wider stg. spacing
W.&L.E.	8x12-10	11½	7-6	Var.	14		T-rail	6x8	

Note: 21 Railroads use no tie spacing blocks but dap outer G.R. from 1" to 1½" - 3 companies use tie spacing blocks

Plate 1

Plate 3. Standard Guard Rail, Union Pacific R. R.

Plate 4. Standard Bridge Guard, Pennsylvania R. R.

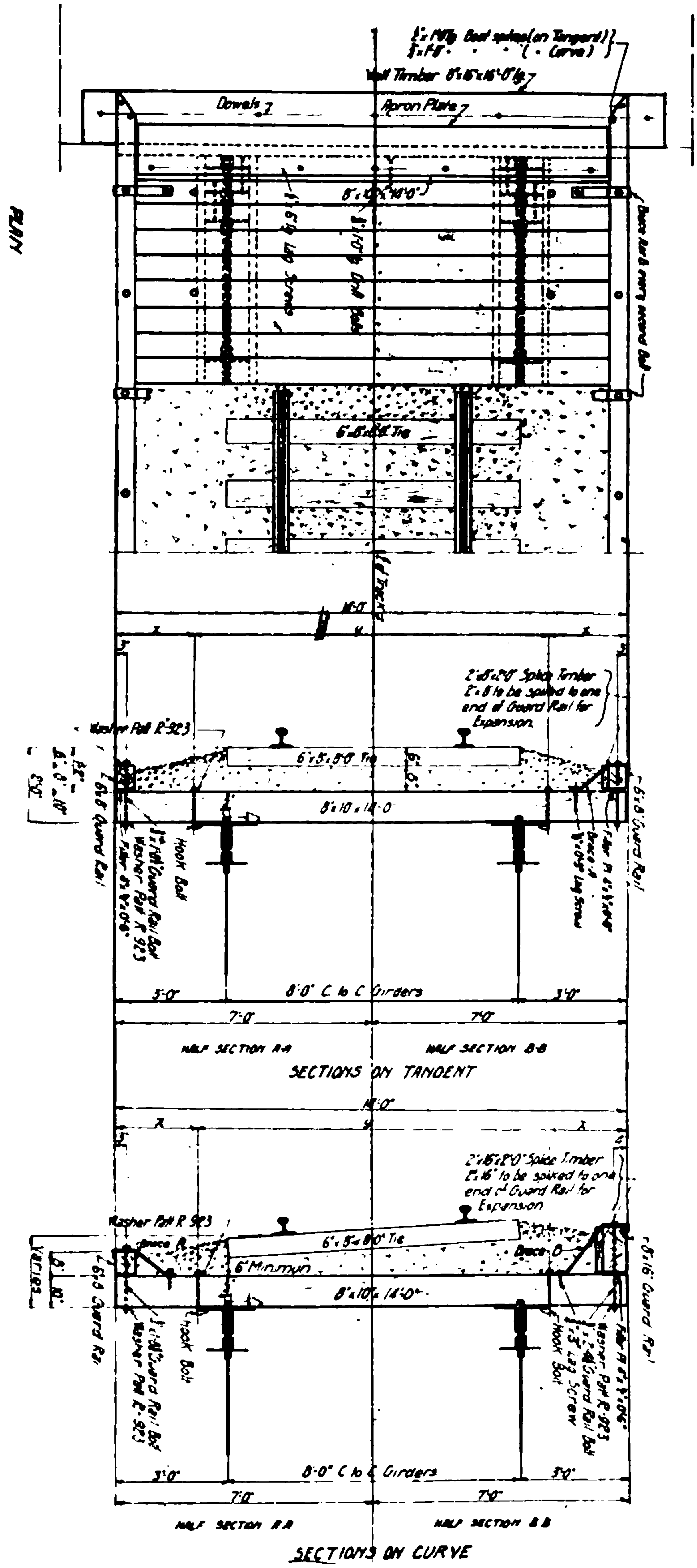


Plate 5. Bridge Decks and Guards, C. R. I. & P. Ry.

Plate 5a. Bridge Decks and ELEVATION Guards, C. R. I. & P. Ry.

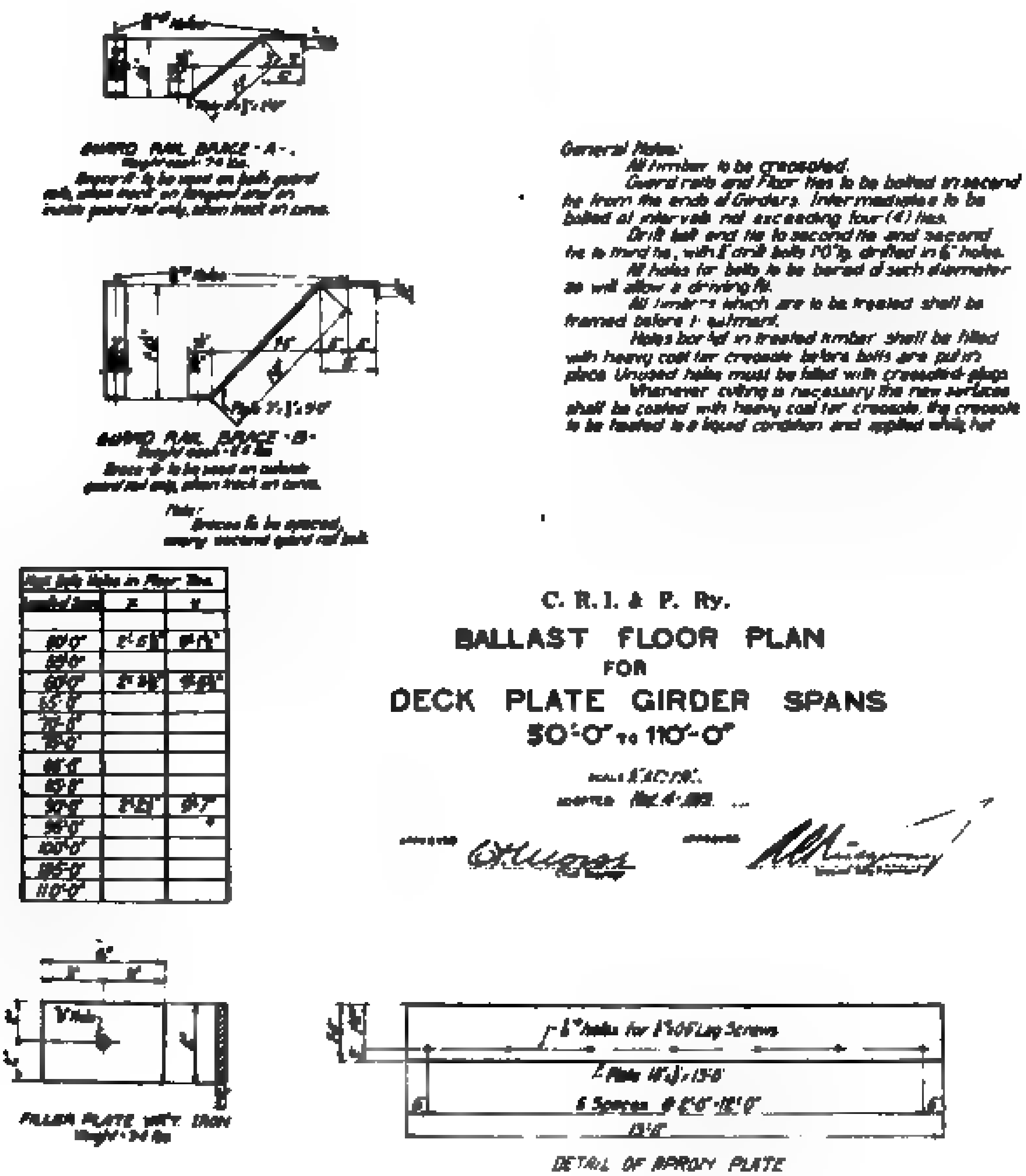


Plate 5b. Bridge Decks and Guards, C. R. I. & P. Ry.

DISCUSSION

(Bridge Floors and Guards)

H. A. Gerst:—I would like to ask if any of the members present have any thoughts on the matter of spiking the rails to bridge ties where the angle bars occur. There seems to be a difference of practice in that respect and I believe the discussion ought to touch on that particular point.

F. E. Schall:—On the Lehigh Valley we do not spike the rail through the slot in the angle bars on bridges, on account of the creeping of the rails. This is especially objectionable on through bridges where the floor beams project above the base of the rail. The spiking of angle bar slots invariably splits the tie so spiked.

D. B. Taylor:—The B. & O. does not spike in the slots of the angle bars on account of the creeping of the rails, just as explained by Mr. Schall.

H. A. Gerst:—I would like to ask if any of the members know of the practice of spiking over the lip of the angle bar through holes especially punched in the tie plate? That is, not spiking through the slots in the base of the angle bar but on the outside of the lip so that it will not prevent the rail from creeping?

E. E. Clothier:—I do not think it is practical to spike through special slots or at the ends of the angle bars.

H. A. Gerst:—I meant through special holes in the tie plates, so that the spikes could be set out.

E. E. Clothier:—We spike through the tie plates. We always keep away from the angle bars. We do not spike at the ends of the angle bars or through the bars.

H. A. Gerst:—Or along the side of the bar?

E. E. Clothier:—Along the bar the spike allows the rail to creep with the change in temperature but does not move the tie.

H. A. Gerst:—But you do spike along the side of the angle bar?

E. E. Clothier:—Yes, but not in the slots or the specially provided holes.

A. McNab:—We space our ties 12-in. centers and spike every other tie. We never allow the bridge men to spike the angle bars but when the section men come along, if anything occurs they will spike them. How are you going to get away from that condition? That has been the great difficulty and we find that we

have more or less trouble right along with the section men spiking the slots in the angle bars on bridges.

W. E. Alexander:—I agree with what has been said about not spiking in the slots or at the ends of the plates and of the angle bars. It is poor practice. It is liable to injure the tie. The rail will creep some and if it creeps the spike will injure the tie where it is fastened here and there. It is only at the joints that that happens but it is liable to injure the tie there. I have seen it done frequently. Our practice is to put hard pine ties on bridges on 12-in. centers, spiking every tie and boring for the spiking. We never spike without boring, as it injures the ties. We have spiked some ties without boring them and the result has been that whether they split then or not, they will split eventually, for the strain on the wood with the action of the weather will split them.

You have heard me speak before about the three guard rails between the running rails. I advocate that yet. The three rails between the running rails will save the ties in case of a wreck where the trucks may be thrown cornerwise. No truck can strike a tie to injure it with three rails between the running rails. You cannot put a truck on there that will tear the ties up but you can tear a whole bridge floor out with two guard rails and none in the center. I have seen that done. It can never occur with the center guard rail. You see some bridges here and there that have the center guard rail; the Canadian Pacific uses it on nearly all of its bridges. We have it in some of our bridges. I wish we had it on all of them because I have seen the beneficial results.

Another thing I do not approve of,—is the general practice of bringing the rails to a point. I prefer the guard rails to go straight down at the end of the bridge or wherever the guards come. I know of a case where we had a wreck due to a pointed guard rail. I am satisfied we would have had no wreck if there had been no pointed guard rail there. The derailment occurred on a curve and the truck worked over the ends of the ties until it was past the point of the guard rail which threw it the wrong way. If there had been a center guard rail, or if only the two guard rails had been there and they had not ended at a point, the truck certainly would have caught it inside of that guard rail and if it had it would have landed on the bridge ties because the ties were long enough to carry it. As it was, it was thrown clear over and we had quite a wreck. There are times when the ground is frozen and the road is icy, that a point may guide the wheels over properly but when

the ground is soft I think there is no place where that point will ever bring the truck in. It will go right over; at least that has been my experience.

J. S. Huntoon:—I approve what has been said about slots. We have had some very disastrous results. I would like to ask some of these gentlemen what they do on drawbridges where rails creep and run and have to be held secure in some instances—where slot spiking has been resorted to and there have been no serious results? We have had trouble putting on the regular track creepers because they are not effective.

A. H. King:—I would say that on a drawbridge the creeping would hardly be noticeable. Disconnect the two ends and it would hardly be worth figuring. As regards the inside guard rail which has been spoken of by Mr. Alexander, there is no question but that the dipped rail at the end that he recommends is preferable to the point. I can see very readily where a derailment might strike squarely on a point and cause a wreck, possibly throw a car crosswise of the track. I think that all we can expect of a guard rail is to skid the derailed truck over the bridge; beyond that if we try to derail it I believe we will miss our calculation every time.

As far as the spiking in the slot is concerned, that is something that we tried to avoid the first year that I was engaged in bridge work. An absolutely free movement of the rail across the bridge is what we always tried to get and we tried to avoid anything that would restrict that.

R. H. Reid:—In regard to the anchoring of rails on drawbridges, we have used a special rail anchor on the New York Central. It is bolted to the rail and bolted to the ties on each side of the floor beams. The ties set close up against the floor beams and they cannot move either way. This is a positive anchor, bolted through the web of the rail and has prevented any movement of the rail on the draw span.

If the approaches are on girders or stringers where floor beams are not available, we bolt an anchor to the top flange of the girder and bolt them the width of the tie apart so that the ties, or as many as may be necessary, fit in on top of the girder between those anchors and the ties cannot move. They are positive and they hold the ties in place.

In regard to the spiking of ties in slots on bridges, I did not suppose there was any question about that. I supposed that it had been generally recognized that it was not advisable to spike

the ties in slots on any bridges. If the rail creeps, the spiking in the slots will tear and destroy the ties. If the rail does not creep it is not necessary. We have had an abundant experience where ties have been simply destroyed—the rail will keep on creeping and the tie plates will shove the spikes ahead of them and split the ties and finally will tear them out. It is the same way if you have tie plates on ties ahead of rail splices where you have splices that will catch the plates. Those splices will go ahead and foul the tie plates and if they keep on going, as they will with the creeping of the rail, they will destroy the ties all to pieces. If the rail must be anchored on bridges, it should be anchored with special anchors next to the ties which are against the floor beams so as to prevent the destruction of the ties.

H. A. Gerst:—I believe most of us are agreed that the rail should not be spiked through the slots in the angle bars, but it has been done and perhaps this discussion will bring out the fact that it should not be done.

W. M. Camp:—Slot-spiking has long been recognized to be a very dangerous practice. Not only does the spike split the ties but creeping rails have carried not only ties but bridge girders off their seats.

It has long been a question whether bringing guard rails to a point in the center of the track is a measure of safety or one of danger. If the derailed truck is running close to the rails then the guard rails brought to center may guide it back toward the proper position. However, if the truck is derailed more than half the gage of the track, it will catch beyond the point and it will usually cause a pile-up at the end of the bridge. For that reason the practice of using three guard rails in a straight line, one at a distance of eight or ten inches from each of the running rails and the other in the middle of the track has been adopted on some roads so that when a derailed truck comes along the idea is that the safest thing to do is to leave it alone. The middle guard rail is just simply a precaution.

I think the place to anchor drawbridges is along the bank. If there is a long trestle approaching the bridge, it pays to anchor the bridge along the bank. A trestle is a very insecure place to anchor rails to. As traffic gets heavier, the tendency of rails is to creep and that tendency is greater today than it ever was before. More double track exists and traffic is heavier, so the question of creeping rails is more important today than it ever was

before and the various devices for anchoring rails are also important. Some even go so far as to put down concrete piers with very heavy anchors. Others take pains that the approaches to bridges shall have extra anchors on the rails for a distance of 1,000 ft. or more in order that there may be security against creeping rails at the bridges even if at points on the road where there are no bridges the tracks are allowed to creep a little.

R. C. Henderson:—The Baltimore & Ohio standard practice is to use a special tie plate. I find that my trouble is to get anything for a bottom plate. There ought to be a plate put under the angle bar. I have picked up half inch iron (or whatever it takes) and slipped it under there and spiked it so it will not work out. We have to use a common spike on the angle bar and spike the rail on the side.

With reference to guard rails we do not use any special point but bend the rail down between the ties at the approach to the bridge, bringing it in to about 6-in. centers. Lately we have been bringing these rails in to about 12-in. centers.

A. McNab:—With regard to drawbridges, we have one at St. Joseph, Mich., with a 200-ft span that gives me more trouble and work than the rest of the line. There is 700 ft. of trestle at the north end. We have tried to do everything we possibly can to keep that drawbridge in operation but every once in a while we have trouble and I do not see how we can prevent it.

W. M. Camp:—There is something similar to that in the tunnel at St. Louis approaching the Eads bridge. They use switch points on the Eads bridge letting the rails run and the switch points adjusting it. When the switch points creep too far they cut out a section of track behind them and pull it back again. That is the only way I have ever seen that problem solved—to use switch points, let the track run and then take it up once in a while on the bridge.

R. H. Reid:—As I understand Mr. McNab, he is asking in regard to the expansion of the rails or of the bridge due to the sun. We have a draw span of 310 ft., where we have to take that factor into account. If the bridge stands long in one position one side will expand so that when we close it it won't close up well and every time we open that bridge we reverse it. It stands in the sun until it is opened for a boat and when we close it we reverse it and put the other side in the sun for a while and if it is not called for often enough by boats we open the bridge and re-

verse it anyway so as to keep the expansion reasonably equal. It is a bridge that works either end to.

In case of a long span which will not reverse, of course that procedure may not be practical but even in a case of that kind if the traffic is not too heavy the draw span can be opened and partially reversed enough to get the effect of the sun on the other side for a while and when it is necessary to close it for traffic it can be swung around and closed without much trouble.

A. McNab:—That is exactly the position we are in. We have got to keep turning the bridge around in the sun occasionally or else in the summer time it is hard to operate.

The President:—No doubt the sun has a considerable effect on the bridge in that way.

SHIPPING COMPANY MATERIAL ECONOMICALLY

REPORT OF COMMITTEE

The subject assigned to this committee is that of shipping company material economically or securing the greatest possible use of the least possible number of cars for this service. The Government has placed orders for 100,000 cars but we need at least 150,000 cars for replacements alone this year. The cars on order will add only 4.3 per cent to our car equipment while the wear and tear of ordinary service depletes our supply 4 per cent. To help meet this condition every one of us must endeavor to contrive the quickest and most economical way to handle our material, and release cars with quicker dispatch and with the lease possible labor.

The first thing to be considered is loading properly and to car capacity. In this the user must keep in close touch with his storekeeper. On our road, we run what is known as a supply train over each division monthly, starting this train from the east end of the division and working west. This train has a regular scheduled time to run and all parties in need of supplies must have their orders in at least six days before the train leaves the main division storehouse, on its trip. Light supplies are loaded in box cars and heavy supplies in gondolas in order that they can be unloaded by air unloaders as shown in the photograph. This unloader is double-ended and two cars can be

Double Air Hoist for Handling Material, B. & O R. R.

unloaded at same time with a small force of men. This supply train gathers up surplus materials and scrap along the line at the same time and in the same manner as it unloads it. We find this method economical and successful. In shipping material in car-load lots it is frequently necessary to load supplies for several different points in order to secure capacity loading. In such instances the material for points farthest away should be loaded first so that the first stop has its material on top and so on. This applies to one division. Where there is a quantity of light material for various points on different divisions car loads of this kind of material can be handled by loading the cars to a transfer point where the lading is transferred to cars which can be

loaded to capacity for that point direct. This will result in conserving cars. In handling our supply trains all parties interested in receiving materials are advised of the day of their arrival and as nearly as possible the time so that they will be on hand to receive and help to unload their supplies it thereby avoiding delays.

Single Air Hoist for Handling Material, B. & O. R. R

In handling bridge materials which are not too heavy a single-end air unloader is a very valuable and necessary help. Such a device can be built on a flat car with a 10 in. cylinder and an 8 ft. lift, although this can be lengthened to 10 ft. with a capacity of at least 3,000 lb. as shown in the photograph. These unloaders can be built very economically and cost about $1,000 in addition to an old flat car properly strengthened. Each master carpenter could have one on his division. With heavy bridge material such as girders, etc., a heavy locomotive crane would necessarily have to be used.

To insure safety and promptness in handling materials and the quick release of cars there must be harmonious coöperation on the part of all concerned. Also if the division car service man would send a statement each month to each party on his division responsible for the prompt release of cars, showing the time cars were received for unloading and the time released and returned and classified in order as to standing in promptness in releasing cars an incentive would be created that would result in much good to car service. In my planning of my work I classify it under the following heads: (1) emergency. (2) urgent. (3) routine. By emergency I include that which demands immediate attention and supersedes all other work. Urgent work is that by which the greatest good to the service can be obtained through the releasing of cars. Routine work is that which follows in its turn accordingly as orders are received.

Let us summarize the leading points considered: (1) Load to car capacity. (2) Load properly to enable cars to be released quickly when several points have material in the same car. (3) Give prompt notification to parties to whom contents are consigned. (4) Provide mechanical air lifts to aid in unloading in order to reduce man power. (5) Create an

appreciation of the demand for car service owing to the war. (6) Arrange for the division car service man to keep a record and notify all concerned as to their standing in the prompt release of cars. (7) Impress all concerned of the urgent need of the most hearty and harmonious cooperation.

Z. T. Brantner,
E. C. Zinsmeister,
G. T. Richards,
A. H. King,

Committee.

DISCUSSION

(Shipping Company Material Economically.)

L. D. Hadwen:—One point the paper does not touch on is that of saving cars. The matter of cooperation with the operating department is very important. It is also important that the material be loaded so it can be recognized readily at its destination and when the load in a car is destined to several points it can be gotten at readily in the order of the stations at which the car is set out.

E. T. Howson:—I think I referred in this convention last year to a remark made by the vice president of one of the largest roads to the effect that when he started this campaign he received a much more ready response from the shippers than from the company men. That has been the experience of other roads. Company men have been used to having cars shipped whenever they wanted them and they have not realized the importance of the conservation of cars to the extent that the shippers have been educated to.

In a recent investigation. I found that two systems are being practiced by the roads in handling supplies. On one road they make up a car each month for each supervisor of bridges or each roadmaster, sending him all the supplies he has ordered for that month. That car goes out whether it has 10,000 lb. or 100 lb. in it. I asked why they didn't consolidate cars where they had small loads and I was told that their experience had been that the man getting the last shipment did not get all his supplies as the first fellow had taken more than his allotment. On the other hand the other road had consolidated and was filling cars to capacity. I asked the officers if they were having any trouble and they said comparatively little, because they checked material thoroughly before it left the yard and it was not very difficult to trace the three or four men in whose care the car had been when unload-

ing certain portions for each man took what was on his requisition and that only. It seems to me the contrast between the two systems is an important one because it represents a good many cars. The situation will be much more acute within the next 60 days when railroad men are going to have from 30 to 40 per cent more traffic to handle this winter than last. With that condition confronting us we can see the necessity of the conservation of cars. Cars should be released immediately when they have reached their destination. There is nothing the men in this association can do that will help to win the war more than to keep the cars moving with full loads all the time.

A. H. King:—I think we can assist a great deal in getting proper delivery and saving time on carload shipments by getting in communication with the stores department and increasing our shipments going in certain directions. For instance, a man may have material going to several different points. If that could be explained to the shipping clerk or the man who forwards it at the storehouse it would bring good results.

R. C. Henderson:—The paper doesn't touch much on small shipments. It is very easy to take care of large shipments that you order 30 days in advance, but I would like to have an expression from men on other railroads regarding the handling of the small items.

The President:—The Baltimore & Ohio started running a supply train monthly about three or four years ago and it was quite a while before we got familiar with the method. We finally made our requisitions read so that we could refer to the shipping points by mile posts and telegraph pole number and have them marked clearly. Then the storekeeper loads the supplies so that the first part of the load going into the car will be the last to come out at the farthest point, either by drawing a line or laying a board beween the supplies. We found a great saving in the use of cars by that method. As a rule you can find out and order the material 30 days ahead. Of course, emergency cases will arise where we have to ship by local freight, but we conserve a great many cars by the use of supply trains. Those cars are unloaded and often reloaded with scrap material and returned. The rail unloaders assist a great deal in handling heavy material such as 12 in. by 10 in. timbers, stringers, etc.

P. J. O'Neill:—That sounds good, but I am on a territory where if one leaves material on the ground over night he won't

have any the next morning. We have a monthly supply train, not for the purpose of carrying material out on the job, but more for the distribution of smaller material. We rescued from the scrap heap several old flat cars and box cars that were condemned by the car department as unfit for general traffic. They are practically used only by the maintenance of way department. When I want to send a carload of stuff I simply have it loaded on one of those cars, and send it out to the crew. They retain the car and move it from place to place until they have used that carload of material when they send the car back with whatever scrap they have accumulated on that trip. I find that the pilfering of material from cars in Detroit and Toledo is very small with this method as compared to what it would be if it were unloaded on the ground. If you unload it and leave it on the ground it is entirely gone in three days. We have lost only a small percentage from the cars.

G. T. Richards:—Cars should be loaded to the proper per cent above the marked capacity of the car. All orders should be inspected daily and requisitions arranged for material going to one or more divisions in the same locality. If a maximum car load cannot be obtained by loading for points on the division over which the car will pass, small items should be loaded for stations at nearby points on the division and the material billed "off at junction."

To avoid delays of delivery and proper unloading, the loads should be so arranged that material may be readily removed from the car upon arrival at each station along the route. As a further precaution our (C. M. & St. P.) shipping notice, form 229, indicates all stations for which the car has material. All material in cars of this nature is tagged separately with the names of consignee and station.

Material should be shipped in as compact form as possible. Doors, windows and other items of manufactured material which may be assembled on the job readily should be shipped " knocked down," and where necessary the several parts should be properly marked to aid in assembling. All material for one job should be shipped in carload lots as far as possible, as for example, in shipping a complete tank,—the tub frame, hoops and fixtures should all go forward in one shipment.

We can ship a great deal of material by double-decking the loads. One or more scows may be placed one above the other

where we formerly loaded but one on a car. We often load 20 in. to 30 in. concrete pipe over a layer of the larger sizes.

In the selection of cars one should see that, when loaded, they move in the right direction, in order that when empty they can be turned over for loading again with the least empty movement. Coal cars especially, when loaded with anything but coal, should be headed toward the mines.

E. C. Zinsmeister:—(By letter)—The shipping of company material economically, while at the same time reducing the use of cars to a minimum, is a broad question and requires considerable planning where other than full carload lots are shipped, consisting of material too bulky to make local freight shipment. My recommendation is to have all bridge and building material assembled at one point at store department headquarters, where it can be piled systematically and proper facilities provided for handling to and from cars. In cases where less than carload lots are required, generally a carload lot can be worked up by shipping the material for more than one job on the same car.

Each division should be equipped with a crane car for the handling of heavy materials, bridge girders and the like. In this connection, a clam shell bucket is valuable for use in unloading sand, gravel, or crushed stone such as is sometimes received in flat bottom cars and for excavations where small abutments and piers are built where the traffic will permit of such operation.

ESSENTIAL WORK

By C. A. Morse,

Assistant Director, Division of Operation, United States Railroad Administration

You are meeting at this convention under new and strange conditions. You have heretofore been in the employ of various railroads. The majority of you here today are the employees of one great railway system, the largest in the world, larger than was ever conceived by Harriman in his fondest dreams of consolidation. You represent practices that have grown up in your respective sections of the country, many of which you have not been able, even with the best efforts of your association, to unify.

Possibly local conditions make it necessary that there should be some variation in the methods employed in different parts of the country, but in the majority of cases, there is no reason why you should not follow a standard practice. Some of you are still line-spiking ties on pile and timber trestles, and are not convinced that this is not the best practice. Some of you are still dapping guard rails, and insist it is the only proper method. Possibly some of you are still using a mortise and tenon on frame trestles. We all know that there is more variety in the practice of bridging than is necessary, and more than any one road would permit on its different divisions.

All of you who are connected with roads taken over by the United States Railroad Administration are now in the employ of one management for the time being at least, and it should be your endeavor to standardize the methods of bridge work on this consolidated railway. Your association is best equipped to do this, and you should, if you have not already done so, say what is the best practice in regard to these things where there is such a difference in the present practice. I would suggest that, in your program for the coming year's work, you go into this matter and be prepared to make recommendations.

In the meantime, we have a condition before us that we have to meet,—a scarcity of labor and of material with a big business on our railroads, our problem is to determine how are we going to take care of this business safely under these conditions.

We all know that it is possible to extend the life of pile and timber trestle bridges indefinitely by replacing each year, the separate items that go to make up the structure. Also in ordinary times it has been considered wise to renew a structure completely when it has reached a certain stage, using the salvage for repairs that would otherwise require the purchase of new material. Now with both labor and material obtainable only in limited quantities, and knowing that we can carry a structure over with perfect safety by only making partial renewals it is up to us to do so. Again we are using, or have used in the past ten years, large quantities of treated material, especially creosoted material. Today it is impossible to get creosote in sufficient quantities to fill our requirements, and to renew bridges completely with untreated material means a comparatively short-lived structure. In repairing structures to extend their life from one to five years, we should use untreated material as it is much easier to secure it than treated timber.

A few years ago railroads could borrow money for additions and betterments for four per cent and under those conditions it was not economical to spend over four per cent of the cost of renewal in repairs that would extend the life of the structure one year. As la-

bor and material were costing much less then than now this did not permit very extensive repairs to be made.

Today, however, money for Additions and Betterments expenditures is costing from 7 to 10 per cent, and labor and material, when they can be had at all, are from 50 to 200 per cent higher than they were a few years ago. These conditions are due to the war which we all hope and believe cannot last over one or two years longer at the most, when they will be changed. Therefore, we are warranted in making large expenditures for repairs at this time, especially for those that will extend the life of the structure until after the war, when renewals can be made for probably 25 per cent and possibly 50 per cent less than they can be made for at this time.

It behooves us, therefore, to make a careful inspection and study of each structure, and if we can repair it so as to make it good for say, four years for 40 or 50 per cent of what it would cost to renew it in full, we should make the repairs. If we can make repairs that will extend the life of a structure 1 year for say, 7 per cent, 2 years for 8 per cent per year, and 3 years for 9 per cent per year on the cost of renewal, such repairs should be made. It will be seen that if this policy is carefully carried out, we will be able to get through the year 1919, with few, if any full renewals of pile and trestle bridges, and that in doing so, a very great saving will be made in both labor and material, and especially in the latter.

The same careful inspection and study should be made of our steel structures. In the first place, they should be kept well painted as nothing gives added life to a steel bridge for so little money as to keep it well protected with paint. Many structures that are a little light can be taken care of by strengthening if in important main lines, and by reducing the speed of trains if on less important lines.

We are all ambitious to improve the class of structures on the territories under our jurisdiction, and rightfully so, in ordinary times. We all have our schemes for strengthening structures to permit heavier wheel loads from which economical operation can be secured, all of which is perfectly proper and laudable, but in times like the present, we must put such work on the shelf, and bend our efforts toward holding to what we have, leaving such things to be done when we are not fully occupied in the one great task of winning the war. We can afford to stop the wheels of progress temporarily, as, if we do not win the war, there will be nothing to make progress for. Let us hold up our ambitions for the time being, and bend every effort to conserve men and material to the end that we may put the Hun where he will work for us, rather than we for him.

We all have waterways that are not large enough for the areas drained. Many of these have been in this condition for years. We naturally are trying to remedy this a little at a time, and rebuild some each year. We should not do any of that class of work during these times, unless where washouts have occurred recently, and then only if we find that there have been previous washouts at these same places within the last two or three years. We can afford to take a chance where this is the only washout there has been at a point for six to ten years, and hold up the work until labor and material conditions have improved.

On building work, the question of replacing old depots is usually up to the management and as there is little chance of state or local authorities making demands for better depots at this time, repairs to present structures are about all that you have on that class of structures. While you cannot do much new building work, you should endeavor to keep the present structures painted, both for looks and to extend their life. This applies not only to structures, but to roadway signs. In keeping the latter well painted you add to the safety of operation. Signs are erected for a purpose. In order to serve that purpose they

must be seen, and a well painted sign is more readily seen and attracts the attention quicker than an unpainted, weather-stained sign, that looks as though it was obsolete, and was there only because some one had negleced to take it down. The actual cost of painting roadway signs is small, while there is nothing on a railroad that makes it look more alive and up-to-date than well painted roadway signs.

Mechanical department buildings are constantly requiring replacement due to the increased size of power; and there is little opportunity for the bridge and building department to do anything in the way of controlling expenditures along that line. There is, however, one thing in connection with buildings where they do have it in their power to make a great saving. That is in connection with the heating. It is surprising to see how little attention is paid to keeping depots and mechanical buildings like shops and roundhouses tight so as to keep out the cold, and keep in the heat.

Good work can also be done in keeping steam, water and air pipes and valves tight and prevent leakage, which means fuel for pumping water and air, and the making of steam. There is no comparatively small maintenance matter where so much can be saved as in this one thing. With the coal situation as bad as it is in this country today, a special effort should be made to do everything that will tend to conserve fuel. Steam pipes should be lagged, windows and doors should have weather strips, floors should be kept tight, and the bottoms of buildings where cold can get under the floors should be boarded or banked up, broken window panes should be replaced promptly and every effort should be made to save fuel. In many cases in the northern climates, double windows and storm doors should be provided.

In many sections of the country, and probably on nearly every line of railroad, there still remain some wooden platforms at depots. As these require renewal, they should be replaced with earth embankments where there is any appreciable amount of filling necessary; these earth embankments should be covered with stone screenings, gravel, cinders or something of that class, (where little or no filling is required, the earth can be omitted,) and do away with the use of wood in these platforms. This applies to platforms at small stations, where it is not planned to put in brick or concrete.

I always associate a master carpenter with the old time freighter, who had on the back of his wagon a "Jockey Box." In this jockey box could be found anything from baling wire to a wagon-hammer, if anything happened on the road he could always find something in his jockey box with which to repair it. A master carpenter's headquarters shop together with outlying buildings is usually a great big "jockey box" from which he can dig up something with which to do any ordinary job, without waiting for the material ordered on his requisition to show up.

I remember dropping into an old time master carpenter's office one day, where I found him buried in copies of requisitions and completion reports. I asked him what he was doing. "Well," he says, "I built several new pile bridges and repaired several more for which I had sent in requisitions for material; the material has just shown up, although the jobs have been done for two months. I am trying to straighten out the charges on those structures, to make them fit the material that I have just received on the requisitions." I have no doubt you have most of you had similar experiences, and that you have material hidden out that was long ago charged out to some job.

If you have not already found it necessary to do so, I would suggest that, regardless of the nature of the "jockey box," in these times of conservation, you should clean out the box, and get all of this material into use. This is no time to have material lying around idle with the idea that it will come in handy sometime; now is the time when it should be used.

Some of the things that accumulate on a bridge and building foreman's hands are packing, O. G. washers and chord and sway brace bolts. This occurs especially where wooden bridges are constantly being replaced with concrete structures or pipe. I have noticed that it is hard to separate a foreman from this class of material, but all surplus material of this kind and all metal scrap should be shipped in to the storekeeper now, while material and scrap are both so valuable.

I want to say a word to your bridge engineer members regarding their second hand material yards or their jockey boxes. They should be inspected carefully; material that can be used for strengthening bridges should be kept; girders and I-beams that can be doubled up should be listed and used as soon as possible and the balance should be scrapped.

It has been customary to save a lot of light girders and pony trusses for possible future public road crossing use. I believe we are warranted at present prices in scrapping all such as we will probably be able to buy new spans, designed purposely for road crossings, by the time we would use these, and get them for less or at least no more than we can get for these as scrap at this time.

My thought is that with the present high prices for all material and scrap, a special effort should be made to clean house, using what is usable and selling the balance to get rid of it, and then start with a clean slate when normal times come again.

One of the bridge and building foreman's fads is "Jacks" and if left alone each foreman would have a jack of every size he might possibly have use for if only once in five years. Every time he has use for a certain size or style of jack, he makes a requisition for it and if times are good and there is much work going on, nine times out of ten he gets the jack regardless of the fact that some other foreman on the division has a jack like it lying idle. Some of you will take exception to this statement, but when you get back on the job, have a report sent in by every foreman of the jacks he has, and you will be surprised at the results. Then if you will make up a list of the jacks a foreman should have on regular work and plan on keeping at division headquarters a few pairs of the odd sizes that are only required by a gang foreman once in three or four years, you will find that you will not have to pass a requisition for a jack for the next two or three years at least.

There is always an accumulation of odd sizes of timber which is not standard. Now is the time when bridge engineers, architects and master carpenters should get a list of this material from the store department and, regardless of standard, plan buildings and odd structures so as to use it. We will accomplish two things by this,—get rid of a lot of dead stock and cash it in at a very high price.

There is usually an accumulation of window frames and sash, door frames and doors, window weights, etc., that should also be used. Glass is high like everything else; by getting after this matter, we can use it at this time, and by so doing, clean up all of these odds and ends. The same process should be applied to anything that the store department has on hand that is not being called for because it is not standard practice for the time being, on that particular road. Material is too scarce, and costs too much in these times for one to be finicky about standards.

The master carpenter is one of the main stays of the division superintendent and of the bridge engineer and while, like all the rest of us, he has his pet hobbies, he is a valuable and important part of the divisional organization. He is usually a man of sound judgment, has good executive ability and is thoroughly dependable. One of the grandest sights I recall has been to see a master carpenter come out and take charge of the rebuilding of some big structure that has washed or

burned out. Talk about your generals in a big battle, he is surely one of them. "Long live the master carpenter."

Your bridge engineer members are of great value to your organization, being able to get a broader view of the bridge problem owing to the larger territory that they cover, and to the technical training that they bring into their work. As the master carpenter is one of the strong men in the superintendent's organization, so is the bridge engineer in the organization of the chief engineer.

Responsibility makes strength in all classes of men, and the responsibility that the master carpenter has for the bridges on his divisions, and the still greater responsibility that the bridge engineer has for all of the bridges on his railroad, have necessarily made each of them a strong and reliable member of the maintenance organization. This is reflected in your association and gives its findings and recommendations strength with all who know the class of men that compose it.

I hope that we shall have the benefit of the best judgment of such men and others that compose your organization in helping to solve the question of how we are to keep up the efficiency and safety of our railroads during the period of war, while men and materials are so hard to get and when the part that the transportation system plays in this war is so important. No one can do it better. You are all essentially, emergency men. The emergency is here now, the greatest in the history of the world. Pull off your coats and get into the game. Show the country what you can do. It's in you to beat the Hun, so go "over the top" and help get him.

THE STEEL SITUATION

By T. C. Powell,

Members Priorities Committee, War Industries Board

The Nation's present business—your present business—is War. When this fact shall have taken firm root in the hearts and minds of the men, women, and children of this country our industrial problems will be found comparatively easy of solution, and the task of readjusting and mobilizing the industries of the Nation to meet the requirements of the military program more than half discharged.

For the winning of the war steel is now the world's most precious metal. It is consumed, or used to some extent, every day by practically every civilized man in every civilized country, and nowhere in such vast quantities per capita as in the United States. The present and constantly increasing steel requirements of this country and its allies for direct and indirect war needs, 100 per cent of which must under any and all circumstances be promptly supplied, are so enormous as to well-nigh absorb our constantly expanding producing capacity. The result is obvious. There will be comparatively little iron and steel left to distribute to those industries engaged in non-war work and to consumers for application to non-war uses. Every possible use of iron and steel or their products which can be deferred must be deferred until after the war. This duty is **personal** and can not be avoided or delegated to your friends and neighbors. No consumption is so small as to be immaterial, and no saving insignificant. Every pound collected and sold to scrap-iron dealers finds its way back into the general supply of iron and steel. "The last quarter hour will win the war," and in that quarter hour the last shell will be fired. That shell may be made from steel that has been saved through the collection of scrap or through denial of the luxury of purchasing steel in the form of articles which have come to be regarded as peace-time necessities.

Among other tasks which the President has laid upon the War Industries Board is that of so distributing the supply of iron and steel available, or which can be made available, as to meet the war requirements and as far as possible the essential needs of the civilian population. This task is being discharged in part through the administration of priorities.

The term "priority" implies discrimination—purposeful discrimination. All priorities are relative and the classifications are based upon the relative importance of the particular industry or the particular plant involved to the war program or to supplying the essential needs (as distinguished from wants) of the civilian population.

Structures, roads, or other construction projects falling within the following classifications are hereby approved, and no permits or licenses will be required therefor:

(1) After having first been cleared and approved by the War Industries Board, those undertaken directly by or under contract with the War Department or the Navy Department of the United States or the United States Shipping Board Emergency Fleet Corporation, the Bureau of Industrial Housing and Transportation of the United States Department of Labor, or the United States Housing Corporation.

(2) Repairs of or extensions to existing buildings involving in the aggregate a cost not exceeding $2,500.

(3) Roadways, buildings, and other structures undertaken by or under contract with the United States Railroad Administration or a railroad operated by such administration.

(4) Those directly connected with mines producing coal, metals, and ferro-alloy minerals; and

(5) Public highway improvements and street pavements when expressly approved in writing by the United States Highways Council.

No building project not falling within one of the foregoing classes shall be undertaken without a permit in writing issued by or under the authority of the Chief of the Non-war Construction Section of the Priorities Division of the War Industries Board.

The Priorities Committee has two divisions, one supervising construction which is immediately connected with the prosecution of the war, and the other, the construction which is non-war. The division in charge of Non-war Construction not only supervises the amount of steel necessary for such construction, but also carries out the plan under which no construction costing above a certain sum can be started without a permit. This division has also undertaken to secure a report from the entire country listing all the building now in progress, including private residences as well as manufacturing plants.

The division of the War Industries Board which handles new facilities directly connected with the war, is in continuous session through the Chief of the Division and his immediate assistants, but in addition to this the Facilities Division holds a meeting every other day and sufficient time is taken to discuss fully the projects submitted by the Army, Navy, Emergency Fleet Corporation, and by the several other divisions of the War Industries Board, as, for instance, the Chemical Division, which works with both the Army and the Navy.

It is recognized that in certain types of construction steel is an essential material, but the Facilities Division does not accept the mere statement that the style of construction decided upon necessarily requires steel, but goes further into these projects to develop whether or not the type of construction cannot be changed without incurring additional expenses and by substituting other available materials, the use of which will conserve steel. The same program is carried out in connection with railroad construction, and in many cases the plans of the railroads or of the contractors working for the railroads, have been modified, substituting concrete for steel, and in some cases, substituting wood for steel.

In the case of bridge construction, the railroad submitting plans for a new bridge or the replacement of an old one is asked to limit the use of steel to the minimum. In the case of shop buildings, the steel is limited to those parts of the building for which it is proved that no other type of construction is possible. Water tanks and fuel oil tanks are being constructed of concrete. Through the War Industries Board also conferences are held with the different industries to see to what extent labor, steel and other essential commodities can be released so that there may be a greater supply for the direct prosecution of the war.

The conservation of material and men is an absolute necessity to the ultimate victory of the Allies. Not only must men and materials be conserved, but the use of the railroad facilities must be limited to necessary transportation and all unnecessary use of them must be cut off. The Railroad Administration is operating the railroads as a unit for war purposes. The development of traffic, the extension of markets and all those activities which are not only commendable but necessary in times of peace, must be considered today from the standpoint of the war. The less waste there is in transportation, the more engines, cars and track facilities will be available for handling troops, munitions, food and the necessary materials.

It is believed that with the co-operation of the people of the country there will be provided a reserve supply of men, materials and railway facilities, and I think we are all firm in the opinion that the existence of this reserve power will be the deciding factor in bringing the war to a complete and satisfactory conclusion.

CARRYING BRIDGES OVER

By C. F. Loweth

Chief Engineer, Chicago, Milwaukee & St. Paul Railroad

Your convention committee is responsible for the subject of this paper. It is to be commended because conservation and "carrying over" are properly watchwords of the day. It is hoped that the paper may be helpful in conserving and carrying over for further usefulness some bridges which, under normal conditions, might not be thought worthy of further service. This paper will deal principally with railroad bridges, but the underlying principles will apply to other kinds of bridges, and, to some extent, to many other structures.

General Considerations

In the maintenance of bridges there are two general considerations to be observed:

1. Safety in carrying the necessary traffic.
2. Economy—that is, obtaining the maximum life from the structure at reasonable maintenance cost.

The necessity for renewing bridges usually arises from one of the following causes:

1. Physical deterioration.
2. Overloading.
3. Rearrangement or relocation.

Physical deterioration usually limits the life of timber bridges and occasionally limits the life of steel bridges in certain situations, such as viaducts over railroad tracks where corrosion and general deterioration is much more rapid than usual for such metal bridges.

The necessity for the rearrangement or relocation of bridges usually arises from conditions outside of the structure itself and need not be further considered in this discussion.

On all railroads which are 25 or more years old, there are usually a number of light-capacity bridges which impose more or less restrictions on the train loadings that can be handled over those lines. This is a very serious problem on lines which have many bridges which were built during the 80's and early 90's.

New bridges are usually designed for the heaviest engine and car loadings in existence at the time. In proportioning them there is, however, a certain margin between the unit stresses which are used and the maximum stress which the material can safely carry. This margin provides an allowance for some future increased engine and train loadings, in addition to the contingencies which are usually embraced by the term "factor of safety."

As an illustration of the increase which has taken place in engine loadings, see Fig. 1, which shows in a graphic way the increase which has taken place on the C. M. & St. P. from 1875 to date. One line of the diagram shows the maximum weights on locomotive driver axles at all times during this period. The other line is a more direct measure of the effect of these loadings on bridges and shows the maximum bending moments on 16 ft. spans for the heaviest engines in regular service throughout the period. While this diagram shows the effect only on 16 ft. spans, such as occur in timber trestle bridges, the diagrams for other span lengths would be similar.

These diagrams show that during the period from 1875 to date, axle

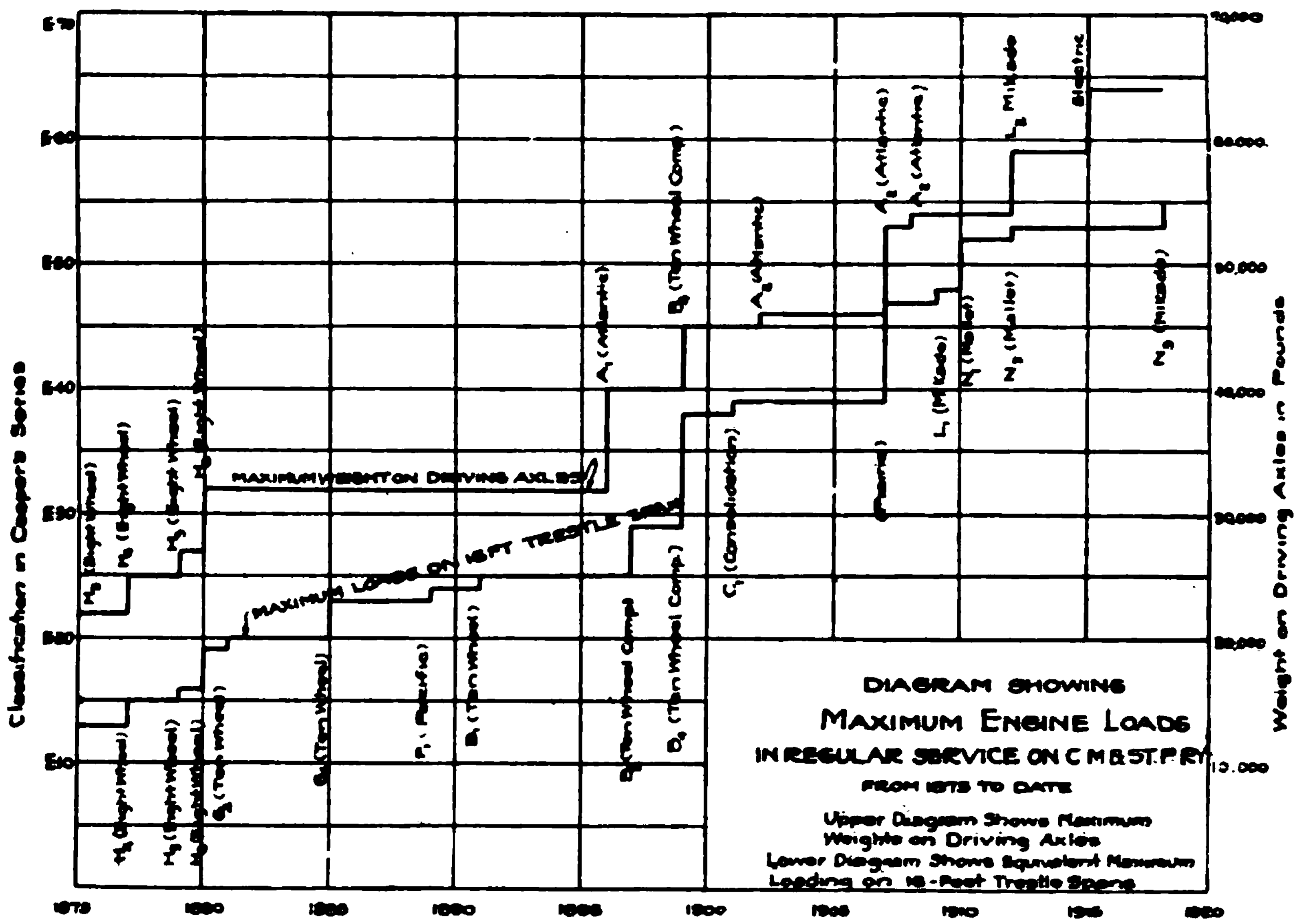


Fig. 1

loads on this railroad have increased from 22,000 lb. to 64,000 lb., or about 190 percent. In the same period the load on trestle bridges has increased from about Cooper's E 13 loading to Cooper's E 55 loading, or about 320 percent. From this it is evident that when the bridges of the period of 1875, and following, were designed, there was no conception of the loads which bridges are now called upon to carry. It is further apparent that these bridges cannot be subjected to present heavy loadings unless their carrying capacity is very carefully investigated in the light of all conditions surrounding the structure.

Classification of Bridges

The term "Classification of Bridges" is used to describe the systematic investigation of light-capacity bridges, with the view to determining the maximum loads which can safely be carried. Formerly, the common practice was, when a new engine loading was up for consideration, to investigate all of the light bridges on the lines where the use of the heavy loading was contemplated. Stresses throughout the structure for this loading were figured and decision then made by the one responsible for the structures as to whether or not the load could be handled safely. Each time a new loading came up for consideration the process was repeated and little or no use made of the previous computations.

The present practice on the C. M. & St. P. is to make an investigation or "classification" of each structure. Its carrying capacity is determined in terms of a standard series of train loadings. New engine and car loadings that come up for consideration are classified in the same series of standard loadings, and it is then a matter of direct comparison to tell whether such proposed loadings can be handled safely over the various bridges. Every bridge whose date of construction indicates that it is of light design, or which is known to be, or suspected of being, overloaded, is thus classified. Every part of the structure is figured or taken into consideration.

Unit Stresses

In making these classifications it is necessary first of all to establish the maximum unit stresses which the various materials can safely be subjected to. For the different materials these maximum safe stresses are taken as near the limit of strength of the material as is considered safe. The maximum safe stresses must be taken low enough so there is no danger of the material yielding, altering its character or reducing its strength to carry loads after being subjected to this limiting stress for any number of times.

As an illustration of what may be considered as safe limiting unit stresses, the following may be taken to apply where the design and physical condition of the structure are known to be first class:

	Wrought Iron	Steel
	Lb. per Sq. In.	
Beams and girders, fibre stress in bending, ...	22,000	26,000
Truss members, tension on net section, ...	20,000	24,000
Timber stringers, fibre stress in bending	2,000	

(With suitable reduction for age for exposed timber over 6 or 8 years old.)

In fixing upon limiting unit stresses for loading old bridges, it is necessary to take into account the following:

Character of design: that the details are well proportioned and direct in action, that there is no ambiguity or uncertainty as to how the members act.

The character of the workmanship entering into the structure as indicated by the reputation of the makers and material test data that may be available.

Deterioration.

Action under load, such as rigidity and freedom from excessive vibration.

The speeds likely to obtain over the structure and confidence as to the observance of any speed restrictions that might be imposed.

The element of certainty as to the assumed loading being the maximum to which the bridge will be subjected.

Importance of traffic and hardship which might result from temporary disablement of the structure.

The probability of early renewal on account of change of line, etc. A higher limit might be allowed for a short time to meet an emergency than for a structure to be kept in service indefinitely.

The general reliability of the data upon which the investigation of the structure is based.

Generally, **judgment** based upon all of the factors surrounding the bridge, its location, service and condition.

It must be recognized that there is danger in setting down a hard and fast rule for the limits to which structures might be stressed. In all cases it is necessary to exercise care and knowledge and good judgment in order to be at all times on the safe side and at the same time conserve the maximum life of the structure.

Standard Loadings

In the systematic investigation of a large number of bridges, it is necessary to have a unit loading as a basis of comparison. The familiar Cooper's series of standard train loadings furnishes a convenient and well-known basis. This series consist of two Consolidation type engines, having a fixed spacing of wheels and a fixed relation between the weights on the various wheels. The weights on the various wheels are directly proportionable to the classes: that is, the drivers for Class E 40 loading, are 40,000 lb. on each axle: For Class E 50 loading, 50,000 lb., etc.

responding to the different span lengths. This is done by computing the maximum bending moments and end shears for the given train loading for each different span length. These are divided by the maximum bending moments and end shears for the unit Class "E-1" loading, for the corresponding span; the result being the "Classification" of the loading.

As an illustration of Classifications of various loadings Fig. 2 is given This shows the classification of several types of the new standard locomotives which have been purchased by the Government and are now being assigned to the various railroads. This diagram shows the classification of the "Mikado," "Santa Fe" and Mallet types for freight service, and the "Pacific" and "Mountain" types for passenger service.

The diagram shows for each of the locomotives the relation between the effect of the given engines on bridges as compared with the Standard Cooper's loadings which are used as a basis for the classification of bridges. The divergence of the several curves from the horizontal shows the differences of the effects of these loadings on the different spans, as compared with the effect of the deeper loading, which is represented by a horizontal line for each class.

Fig. 2 A

Description of U. S. Government Standard Locomotives

	Weights	Wheel Base

For example, bridges having a classification of E 55 throughout could safely carry the loadings which fall below the line marked "E 55" in the diagram for the span lengths for which the diagram lies below the E 55 line, but for span lengths for which the diagram is above the E 55 line, bridges would be stressed higher than their classification would permit.

Take for example the Santa Fe locomotive –2-10-2 (55) type, having 55,000 lb. on each axle: It will be noted that for spans under 24 ft. the classification of this locomotive is lower than E 55 loading, for spans between 24 ft. and 66 ft., above E 55 loading and for spans above 66 ft., the classification is again below E 55 loading.

From the diagram in Fig. 2 it will be seen that locomotives 2-10-2, having 60,000 lb on the drivers, 2-10-2, with 55 000 lb. on the drivers, and the "Mallet" types, 2-8-8-2 and 2-6-6-2 have a classification for 50-ft. spans greater than the limiting classifications of this member of the bridge and could not be permitted to run without speed restrictions.

The other locomotives have a classification less than the classification of the member considered and may be permitted to run over the bridge without speed restrictions, providing no other member of the bridge limits the loading There is no loading shown in Fig. 5 for carloading which would be limited by this member.

The classification for Pacific and Mikado type locomotives is shown both for single and double-headed engines. It will be noted that for single engines the classification for spans over 50 ft. drops off considerably, while for double-headed engines it is about the same for long spans as for short spans.

Speed Restrictions

In the foregoing the classification has been determined with an allowance for the effect of the maximum speed over bridges. Where speed is reduced the effects of the live load are much less, and the allowance for impact and centrifugal force, if any, may be correspondingly reduced. This will, of course, permit heavier loadings to be operated at reduced speed than at full speed.

From the tests conducted by the American Railway Engineering Association, it is found that the maximum impact which will be obtained at reduced speed is:

Less than 30 percent for a speed of 10 miles per hr.

Less than 40 percent for a speed of 15 miles per hr.

Less than 50 percent for a speed of 20 miles per hr.

Less than 55 percent for a speed of 25 miles per hr.

Where the classification of the bridge indicates that some loadings which it might be desired to run cannot be handled at full speed, the classification for certain reduced speeds should be worked out.

Consider the example of the hip vertical above, for which the live load classification, loading at rest, amounted to E 92.1. For a speed of 10 miles per hour, taking impact at 30 percent, the liveload classification is $\frac{\text{E } 92.1}{1+.30} = \text{E } 70.8$.

For 15 miles per hr. taking impact at 40 percent the liveload classification is $\frac{\text{E } 92.1}{1+.40} = \text{E } 65.9$. At full speed the impact allowance is 86.5 percent, and the liveload classification $= \frac{\text{E } 92.1}{1+.865}$.

Therefore,

For loads which classify below E 55.2 no restriction to speed.

For loads which classify between E 55.2 and E 65.9 restrict to 15 miles per hr.

For loads which classify between E 65.9 and E 70.8 restrict to 10 miles per hr.

An inspection of Fig. 2, indicates that the effective span of the bridges and the characteristics of the engine loadings determine in a very large way whether or not the given loading can be run over the bridge, and that it is unsafe to attempt to determine whether or not the engine loading can be handled over a bridge simply by knowing its total weight.

There is, unfortunately, a misunderstanding among some railroad operating officials, as to the effect on bridge structures of such complex loadings as locomotives and cars. In these cases it is assumed that the effect is the same for all locomotives of the same total weight, and that the bridges which are classified as being safe, or otherwise, for all locomotives of given total weights. If this practice must be resorted to the limits set must be on a very conservative basis, otherwise there would be danger of certain types of locomotives having a serious effect on some bridges producing unsafe conditions. The practice would not be economical because it would either lead to the premature renewal of some bridges or to an unnecessary ruling off of certain types of engines.

Schedule of Loadings Permitted

After completing the classification of the light bridges on various lines, a tabulation is made giving the classification of the limiting details of each bridge which limits loadings. Classification is also made of all engines in service, single and double-headed, with appropriate train loadings following: also of wrecking derricks and other heavy loads. A list is then made of the loadings which may be permitted to run over the bridges on the several lines, with speed restrictions if any. This is issued in convenient form for use of operating officers.

Where there are a number of bridges on one line which would require restrictions as to speed for certain classes of loadings, it is generally desirable to rule off such loadings, as it is difficult to secure the observance of a large number of speed restrictions. Double-heading of engines should be assumed, and where it is not permitted should be especially noted. The schedule of loadings permitted should also indicate the heaviest car loadings permitted over the various lines.

Where Low Classification Usually Occurs In Bridges

In older bridges there are certain parts where low classifications can usually be expected.

These have been found to occur most often in the lightest members of the structure and members which carry the smallest deadload stresses. This can be accounted for by reason of the low working stresses used for classifying bridges. In proportioning a member, a portion of the area of the member can be taken as carrying deadload stress and the remainder liveload stress. As the deadload stress is constant, a smaller area would be required where a higher unit stress is used. This, therefore, leaves a portion of the area originally provided for deadload available to carry liveload stress.

It is found that the floor systems of bridges generally have a lower classification than the girders or chords of trusses. The low classification of stringers is generally in the section of the flanges near the center, the riveting in flanges near the end of stringers particularly if they are shallow, and in the riveting connecting the stringers to the floor beams. Floor beams, if of shallow depth, frequently show a low classification in flanges near the stringer connections, also in the riveting in flanges near the ends of the floor beams and in splices connecting the webs of the floor beams to the gusset plates, particularly in types where the lower part of the floor beam is cut out to fit around the ends of the trusses.

In plate girders the flanges frequently show low classification at points where the web is not fully spliced near the center and at points near the ends of cover plates. The flange riveting near the ends of girders frequently has a low classification, particularly where the girders are shallower at the ends.

Webs of plate girders show low classification near the ends of the girders where there is a relatively large expanse of web, unsupported by stiffeners. The web splices near the end of the span have a low classification where only one line of rivets is used in each side of the splice.

In trusses, the posts and diagonals near the center of the span usually show a low classification. This is particularly true of the diagonals and counter-diagonals of light eye bars or loop rods.

Suspenders, or hip vertical members, frequently have a low classification. The classification of end posts and top chords of truss bridges is frequently low on account of the eccentricity of the member with respect to the location of the pin.

The pins of old truss bridges frequently show a startlingly low classification where computations are made in accordance with the usual methods and it is necessary to take advantage of certain conditions which are more favorable than the usual assumption to help out the classifica-

tion. Where eye bar members, consisting of more than two eye bars meet on a pin, a slight redistribution of stress in the several eye bars will frequently increase the classification of the pin, and this is justifiable as being in line with the way the structure actually works.

Where certain members have wide bearing surfaces on the pins, the center of pressure can be taken near one edge of the bearing surface, and thus increase the classification of the pin and, at the same time, approximate more nearly the actual behavior of the detail.

It is also permissible to use higher stress for figuring pins than for the other members of the structure. The following illustrates what might be considered permissible, providing there is assurance that the material is of good quality and the computations take account of all the forces acting:

Wrought Iron, ...	40,000 lb. per sq. in. in bending
Soft Steel (0.1%), ...	45,000 lb. per sq. in. in bending
Structural Steel (0.2C), ...	48,000 lb. per sq. in. in bending
Mild Steel (0.25C), ...	52,000 lb. per sq. in. in bending
Medium Steel (0.35C), ...	56,000 lb. per sq. in. in bending
Hard Steel (0.45C), ...	64,000 lb. per sq. in. in bending

It is to be noted that in bridges built in the later 80's and early 90's hard grades of steel were frequently used for the pins.

In timber trestle bridges, the stringers, in bending, usually show low classification. On account of there being three or more sticks acting together, it is permissible to use a higher unit stress for trestle stringers than for a single stick, as the average strength for the several pieces exceeds that of poorest one.

On account of the exposure to the weather and the deterioration which gradually takes place, the allowed stress in timber stringers should be reduced as the age of the bridge increases. Where the bridges are thoroughly inspected and defective timber promptly replaced and subject to the same general consideration given above, for metal bridges, the following unit stresses might be taken as a safe practice for maximum fibre stress in stringer bridges without allowance for impact:

For stringer bridges 6 years old 2,000 lb. per sq. in. and reduced about 100 lb. per sq. in. for each year following.

The above figures are based on Douglas Fir or dense yellow pine and for climatic conditions prevailing in the North Central states. In more arid regions where longer life of timber may be expected, the reduction in stress for age need not be so rapid.

On account of the comparatively short life of timber bridges and the ease with which they can be renewed there is not generally the same urgency in establishing maximum safe stress limits as in the case of the more permanent metal bridges. In timber truss bridges the lowest classification usually occurs in the floor beams, in truss rods and diagonal braces.

It has been found that metal bridges suffer frequently from corrosion at the top flange of stringers and floor beams on account of action of brine drippings from refrigerator cars.

In bridges where ties are supported on shelf angles, riveted to the web of the girders, the shelf angles frequently show considerable corrosion and tend to break in the root of the angle. In pin connected trusses, excessive wear sometimes takes place in the pin bearings, particularly in draw bridges.

Metal bridges and viaducts over railroad tracks frequently show excessive corrosion in the floor system and laterals due to smoke and gas from locomotives, also from the fact that the solid floors of such bridges do not permit the steel work beneath to dry out quickly.

Metal over-head bridges having a scant clearance, so that the stacks of locomotives come close to the steel work, frequently show excessive wear from the sand blasting effect of cinders from the exhaust, particu-

larly on ascending grades where the locomotive is worked hard under the bridge.

Possible deterioration of the structure of the metal itself has in some quarters been a matter of apprehension, but it now seems to be recognized that no such internal deteriorating action takes place where the bridge has not been subjected to excessively high stress; if crystallization is found in the metal of a structure, it probably was there at the time the structure was built, on account of improper methods of manufacture of the material.

It may, therefore, be taken as a certainty that iron and steel bridges, if not reduced in section by rust, etc., and if not shaky on account of inadequate bracing, are fully capable of carrying the figured loads at reasonable limiting unit stresses, provided they are carefully inspected and properly maintained.

Strengthening of Light Bridges

Strengthening of light bridges may be either a matter of reinforcing minor details, which are found to limit the carrying capacity of the bridge, or may consist of heavy reinforcing in an attempt to increase the strength of the structure throughout.

The minor strengthening can usually be done at small expense and is an economical method of getting considerably greater life out of bridges. Heavy reinforcing may or may not be economical, as it involves work being done in the field which is expensive, and the maintenance of traffic during the time the work is in progress, which involves some risk to traffic, and is unusually expensive. On very large bridges where the cost of replacing amounts to a very large sum, some very extensive strengthening operations have been carried out economically.

In making plans for reinforcing bridges, it is usually preferable to add new material to the structure so that the present structure is not weakened temporarily, rather than to remove parts and substitute heavier ones, though the latter has sometimes to be resorted to. The descriptions of the points at which low classification usually occurs suggest in themselves how these might be strengthened.

In plate girders the top and bottom flanges may be strengthened by additional cover plates, particularly at points where the web is spliced and not effective for carrying its proportion of the bending stress. Where there are no cover plates on the girders, cover plates of desired length can be added. On plate girders where there are two or more cover plates, additional cover plates would be nearly the full length of the girder and expensive to apply. Plate girders can be doubled up to make deck spans, using three or more girders per span at small expense and thereby using up light girders and providing bridges of large carrying capacity.

Where waterways or other undercrossing conditions permit, timber bents can be placed under spans to strengthen them.

Where the rivets in the flanges of girders show low classification, larger rivets can be substituted for existing rivets, or, where the rivet spacing permits, additional rivets can be driven.

Where the web plates give a low classification, additional stiffeners can be placed in the panels near the ends of the girders to give additional support to the web and increase its classification.

Shelf angles can be strengthened by short vertical stiffeners beneath them. Where web splices with low classification occur, these can be replaced with wider splice plates with additional rows of rivets in the splice.

In through bridges the stringers can be reinforced by additional riveting, by the placing of additional stringers of either timber or steel. and by shifting existing stringers to secure a better distribution of the load. Where stringers are spaced so that some stringers do not carry their full proportion of load, it is possible to introduce cross bracing so that all the stringers in the panel act together to carry the load and relieve an excessive load on certain stringers.

Floor beams can be reinforced by cover plates or angles added to the flanges, by additional riveting, or by shifting the stringers toward the trusses, to reduce the bending in the floor beams. In very old bridges floor beams are frequently of much lower classification than the remainder of the bridge and can sometimes be replaced with entirely new floor beams at a reasonable expense so as to get additional life out of the remainder of the structure.

In trusses, diagonals and counters can usually be reinforced with additional bars or rods with loops over the truss pins and connected by turn buckles to provide adjustment. Similarly, botton chords of eye bars can be reinforced with additional bars with yokes bearing on the heads of the original eye bars.

End posts of through bridges, whose low classification is due to eccentricity of members, can be strengthened by placing angles or plates on the sides of the members, so as to make the cross sections better balanced, and reduce eccentricity.

Where pins have low classification, it is sometimes possible to move the members on the pin to reduce the bending. In some cases, diaphragms placed inside of built-up numbers will relieve bending on the pin. The pins themselves can be strengthened by replacing them with high carbon, or special alloy, steel pins of the same size, or, if additional strength is required, by boring out the pin holes and putting in larger pins. This operation has been done a number of times, but requires rather elaborate arrangements for holding the members in position while the pins are removed, and for boring the holes.

Timber truss bridges can be strengthened by placing additional floor beams, diagonal braces or truss rods where needed.

Where timber trusses are old and have commenced to open slightly in the joints or show other signs of diminished strength, they can be strengthened temporarily and carried for a few more years by placing timber bents under the panels points, two or three panels from the end of the span. This has the effect of reducing the span length and stiffening the span.

Timber trestle bridges can be strengthened readily by additional stringers.

The cost of strengthening bridges varies with the size of the job, the amount of staging required, the amount of moving it about to reach different portions of the work, the size of the crew available, the distance traveled by crew, tools available, etc. In a general way, it has been found that the cutting out and replacing of rivets on ordinary strengthening jobs costs from 25 ct. to 75 ct. each. Drilling and driving new rivets, 50 ct. to $1.00 each; that is, the cost of such work will be given by the total number of rivets driven at these unit places, plus the cost of additional material required.

With the maintenance of old bridges of light capacity, the question continually arises whether it is more economical to strengthen the structure or renew it. As a general proposition it would be permissible to spend each year for strengthening an amount equal to the interest on the investment in a new bridge, less the cost of additional maintenance required by the old bridge on account of the greater attention it receives.

For illustration, consider a few lengths of through spans designed for E-55 loading, replacing similar spans designed in the early '90's, new steel work being taken at 5 ct. per pound erected, falsework at $10 per lin. ft., removal of the old structure at $10 per ton, salvage on old spans at 2½ ct. per pound, additional cost of maintenance of the old span on account of additional inspection, classification and supervision required, $1 per ft. of span per year. The last column of the following table shows the amount which we could afford to spend per year in strengthening old spans rather than to renew them. The costs shown in this table are for

Span	New Steel Weight (pounds)	New Steel Cost Erected	Salvage	Net Cost	Interest on net cost at 5 percent	Available for strengthening each year
50′	66,000	$ 4,330	$ 1,130	$ 3,200	$ 160.00	$ 110.00
100′	218,000	13,390	3,700	9,600	480.00	380.00
200′	800,000	46,800	12,500	34,300	1,715.00	1,515.00
300′	1,600,000	92,200	25,000	67,200	3,360.00	3,060.00

illustration only. As they fluctuate from time to time the resulting economies will vary accordingly.

The writer has in mind a bridge having three 400-ft. spans which if renewed about ten years ago, as some railroad managements might have done, would have cost about $370,000, after deducting the salvage value of the old spans recovered. The interest on this investment for the ten years would have amounted to about $185,000. Instead, however, of replacing these spans they have been carefully maintained and inspected and the details strengthened wherever the classification showed that it was necessary to carry the heavier traffic. The actual cost of strengthening together with the additional maintenance expense has amounted to not over $100,000 during this period, showing a saving for this one bridge of about $165,000 because of the policy of getting the longest practicable life out of the structure.

This illustration is intended to show only one way in which the problem may be considered. With old and light bridges a limit is reached beyond which it is not economical to strengthen them, and replacement then becomes necessary. It must be recognized, of course, that a newly designed and heavy structure is preferable to a lighter one. It is possibly true that in case of a serious accident on a bridge, a light structure might be destroyed while a heavy new structure might withstand the same treatment without being seriously disabled. Such consideration must be taken into account in shaping the general policy in keeping light bridges in service.

Acknowledgment is here made of the valuable assistance in the preparation of this paper by R. L. Stevens, assistant engineer on the C. M. & St. P., who has in the past aided largely in the work of classifying the bridges on that railroad and has prepared the data which has been worked up in the illustrations and diagrams herewith.

DISCUSSION

(Carrying Over Bridges.)

The President:—We will now take up the discussion on Mr. Loweth's paper.

E. T. Howson:—One thing to which Mr. Morse referred in his paper yesterday is closely allied with the subject in Mr. Loweth's paper; that was that we could afford to spend a lot more now in repairs to carry structures over than we could under normal conditions. The cost of doing work is so much greater now on account of the higher charges for labor and materials and the

delays which necessarily ensue, that, as Mr. Morse said yesterday, we can afford to spend up to 30 or 40 per cent of the cost of a new structure for repairs that will carry a bridge three or four years longer or until we return to normal prices. That situation is being brought prominently before railroad men now by the difficulty the Government is encountering in closing negotiations with the roads for the acceptance of cars. The United States Railroad administration ordered 100,000 cars and distributed them between the railroads which it thought needed them. The officers of these roads are hesitating about accepting those cars now and paying for them at the high prices which now prevail. As a result the Railroad Administration finds itself with 100,000 cars on hand and many railroads unwilling to take them over and pay for them.

The situation with reference to bridge work is the same. It costs so much more than in normal times to renew bridges that if a bridge can be carried over, even by extensive repairs, it is well worth while now. It used to be that the repairs justified would be a relatively small per cent of the cost of a new structure, but that per cent is greatly increased now.

L. D. Hadwen:—The point Mr. Howson just emphasized raised another question in my mind,—whether our bridge inspection in these times is sufficient, or, if enough attention is being given to the possibility of carrying our timber bridges a little longer? The general attitude of bridge inspectors is to play safe. For this reason there is danger of their recommendations being a little premature. I think it behooves everybody connected with the maintenance of bridges to bear in mind that it is advisable to give very serious consideration to any recommendation for the renewal of timber bridges.

J. S. Robinson:—I think we ought to bear in mind, that in trying to carry over old bridges we must inspect them more often than we have been, being particularly cautious that old bridges are kept safe, that no member in a truss or any other kind of bridge is unsafe. That requires very close examination. Any member might fail under heavy loads now and not be observed unless it is looked over carefully.

Lee Jutton:—The paper which has just been read had to do mostly with the larger structures. Such structures are handled by the higher officers and are carefully studied before a decision is reached. On every railroad a lot of minor repairs are made with-

out anybody perhaps knowing about them except the local foreman, or the district foreman. I think we ought to get a little different viewpoint into those men's minds and have them think twice before they renew planking, ties, etc. They all have standards to go by, but all standards are now being put aside and a second thought given as to whether that work should be done immediately. That was brought to my mind because of a little pamphlet on fuel in which it was shown that 90 per cent of the fuel used on railroads is locomotive fuel and the other 10 per cent for other purposes, such as heating plants, pumping stations, etc. Figures were given to show what an enormous saving could be made by conserving a small percentage of this 10 per cent.

It is all right to study the large bridges carefully and where we used to rebuild them to carry them over by reinforcing them. While it is also very important that a man should make small repairs, it is just as important that he give these things careful consideration and think twice before he makes repairs that ordinarily he could do without.

R. H. Reid:—On the New York Central repairs on bridges are laid out by the bridge supervisor, even the renewal of ties, the tightening of bolts, repairs on ribbons or so-called outer guard rails and everything else. In these times, of course, many of those minor repairs have to be cut out.

Now, on bridges of both steel and wood we frequently find a few poor ties. If those ties are scattered they are left until a more urgent time. In the same way the ribbon may be sap rotten, but as long as the ties are in place and there is no evidence of the ribbon letting go it can be carried over. The stringers will frequently show decay at the joints near the ends while they may be sound in the middle. Generally the joints over the bearing will stand considerable decay before they give out. The same is true of the caps. They may show decay in certain parts, especially at the end, but there is no immediate need of renewing those caps. In ordinary times when stringers show certain conditions it may be well enough to put in extra stringers and release or take out the decayed ones and replace them, but in times like these such work can frequently go over until labor and material are more plentiful.

Where we have I-beam stringers in steel bridges which have become too weak with the increase in weight of motive power and of cars we have replaced them with wooden stringers. In other

cases where wooden stringers were not heavy enough we have replaced them with second-hand I-beams sometimes taken from other spans. In other cases we have taken plate girder spans from tracks that are now unused and installed them where they were more urgently needed.

A. H. King:—It seems to me that conditions today as far as repairs are concerned are not much different than ordinarily. I remember during all the time of my service that we have been expected to know if a structure was safe and if on our regular inspection we found that there was anything we thought was unreasonable or unsafe we were supposed to get busy. We have always had plenty of material to make a structure safe. All I can see to the problem today is that we have got to bend our energies a little further toward inspection and to make inspections oftener. I don't feel that the general situation is any hardship at all. I am always glad to see the opportunity to work in second-hand material.

J. S. Robinson:—We have cases on our lines where we run refrigerator cars and the dripping from the brine causes bad results. We have found I-beams and deck girders where the flanges were corroded to a knife edge from the action of the brine. We watch those bridges very closely. That is one thing I had in mind in urging frequent inspections of bridges we are trying to carry over. We have carried over a number of girder and I-beam bridges a year longer than intended by watching them closely, scraping off the brine and cleaning them a little. This requires constant inspection and constant supervision but in that way we are able to carry them over. It is difficult to get steel structures now.

A. S. Markley:—The danger of rotten timber in wooden bridges should not be lost sight of. Ninety-nine per cent of the fires result on account of decayed timbers. We should remove all timber that is bad before fires start. Of course, we have sap-rotten timber but we can remove that. We should not lose sight of rotten stringers between the joints and down in the corbel where 90 per cent of the fires originate. We can't be too liberal in our inspections.

F. E. Schall:—Mr. Robinson's discussion brought out a point that I think is very timely, the matter of brine drippings. He said something about flanges being corroded to a knife edge. We have had similar cases. We have had to take them out and

reinforce them. As has been said, this requires close inspection.

In regard to timber, I think Mr. Markley's remarks were very timely. We have been cutting off the sap rot for years. We had one sad experience in which we lost about 3000 ft. of tracks through fire on Newark Bay. You must make closer supervision. Don't let the foremen take the action, tell them what to do. It is harder now than it ever was to attend to your duties in such a way that you will conserve material. The foreman will take the safe course, and many times he will let a crew renew members that could be carried over. The supervisor must keep in close touch with every foreman and tell him what to do. By so doing he can save a lot of money and a lot of material and still be on the safe side.

D. B. Taylor:—Our idea is to have a bridge and building inspection every fall. The master carpenter personally is responsible for the condition of his structures as to ties, painting and the renewal of rivets where corrosion is setting in. We figure on the necessity of cutting so many rivets out and replacing them with new rivets in the upper and lower flanges and in the stringer connections in the floor beams, replacing all ties, repairing masonry or any other work the structure needs, as well as painting the bridges whenever they need it. We count the split and bad ties. By this method it is put strictly up to us to know how every structure is as to caps, piling and everything. We know that the master carpenter personally is in charge; it isn't left to foremen in our territory.

A. H. King:—I wish to say that on our main line of 315 miles, we have strengthened all of our trestle bridges by adding additional stringers on each side and where necessary we have placed an extra post. Another method of conserving timber that I found is working out very favorably, is that of turning or shifting ties in order to get a better spiking surface and to turn down slightly decayed portions. Instead of scrapping our guard rails on account of broken daps, we cut blocks and nail them on the top of the cord to hold the ties in place. I think we save a great deal of labor and material in this way. I don't approve of this so much on main lines as I do on branches where the traffic is not so heavy and the power is lighter.

R. H. Reid:—We have on the New York Central a pile bridge that was built in 1892. In 1903 we put on a new deck. The piles were fairly good but we drove a few extra piles in

each of the bents to strengthen them. That bridge carried traffic until last year when it was renewed. We have timber bridges that were built in 1898 to 1900 that are still carrying traffic. One of these bridges built in 1900 has the original stringers, ties and bents. We have quite a few others that are from 15 to 18 years old. One can make a good job of repairing and carrying over bridges if good foremen are employed.

A. H. King:—We are doing some repair work of a semi-permanent character. When the piles decay badly at the ground line we cut them off a few feet under the ground and build a concrete pier, using the old pile stubs as long as they will last and then substituting frame bents.

R. C. Sattley:—Many bridge men place a stub on top of a pile that has been cut off below the ground. I think it is good practice to indicate in some way that this substitute is a stub. As a general rule a square timber extending into the ground denotes that it is only a stub.

R. H. Reid:—The bridge records should show which are piles and which are stubs. On the New York Central we keep a record of every pile that is stubbed or spliced. If the inspector is onto his job he can tell if it is a stub or a pile from its appearance, but his record ought to be a guide. I do not think there is much economy in cutting off piles and building concrete piers on them and then putting frame bents on those piers. I think it is just as well, if not better, to put the bent directly on the pile stubs, then you can renew that bent as long as the piles remain sound and you know what you are doing.

Something was said about using old stringers to make frame bents. One needs to be careful in doing that; if one uses soft wood stringers they may not carry the load. They are liable to fail by crushing or splitting. I found that to occur in a good many instances where it had been tried on some of our lines which were operated independently before we took them over.

The Secretary:—Mr. Reid says it is better to cut off piles below the ground line and then place bents directly on the cut-off piles. That is putting timber right back into the ground and in certain soils and locations wood rots very quickly. In many locations on the Northwestern, and especially in the western country, we have found it advisable in many instances to build the small concrete piers, then the frame bents come well above the ground and will last as long as the rest of the structure, where-

as they would not last but a short time if they extended into the ground. These piers may then be considered permanent for future wooden trestles.

Mr. Bainbridge:—The discussion has turned more to the minor repairs of timber bridges than along the lines which Mr. Loweth's paper seemed to cover. Mr. Loweth's paper covered steel bridges, the idea being to try and get some standard method or some expression of how the various roads were determining the age or the period when such bridges should be renewed or replaced with stronger structures. There does not seem to be any standard practice in regard to that. We have, for a number of years been trying to improvise a method whereby we could determine with some degree of satisfaction to ourselves when these structures should be taken out and what limiting stresses should be used in determining this.

The paper hasn't touched much on the method adopted by our road in maintaining timber structures. I don't believe there is anybody from any road here who probably has not used nearly all of the methods that have been discussed in maintaining timber structures, cutting off the piles below the ground and putting concrete on top of them, cutting them off and putting other posts in, putting in additional stringers, etc. I think such methods depend a great deal on local conditions, the traffic that goes over the bridge and things of that character.

R. H. Reid:—The first thing to consider in determining the necessity of renewing steel or iron bridges, is the calculation of their loads. We have a pretty good idea of what the loads are going to be or what are proposed and we can determine what the stresses will normally be for those loads. In the case of plate girders, if the stresses are not actually prohibitive, we can let them put the loads on for a while and watch the girders. If there is an increase of say 20 per cent in the loads over what they have been carrying, let them put those loads on for a while and watch the results. If the rivets do not loosen up and there is no danger, then go on until they do. Of course, if there is an increase of 50 per cent in the loads and the indications are that prohibitive stresses will be created it may be policy to take the structure out without further investigation, but for ordinary increases we can safely let them put the load on and watch the structure. We have structures that are from 30 to 40 years old and still carrying our maximum loads and carrying them safely.

In the case of trestle bridges it is not so easy to determine from appearances when loads are becoming dangerous.

Mr. Bainbridge:—I would like to ask Mr. Reid a question. In watching the steel bridges do you figure the load that is allowed over the bridge first or do you let the load go over and see the effect of the load on the bridge? He mentions that he has bridges 30 to 40 years old still in service. We have too but they were designed for our heavier lines at that time and have probably been taken out and put on some of the branch lines where the increase in weight of power has not been anywhere nearly in proportion to what it is on our main lines. We determine what the bridge is, steel or iron, and figure what it is good for at limiting stresses. When the bridge was designed it was probably designed for a certain class, maybe at a stress of 16,000 lb. Now if you increase the stress to 20 per cent and still maintain the 16,000 lb. your increase in load is not going to be very great, but if you increase the stress to 20,000 or 22,000 lb. and you increase the load much more in proportion it will be.

R. H. Reid:—If you increase the load you necessarily increase the stresses in the structure. But we calculate the structure for the load before putting these increased loads on it to see what stresses they are going to give.

F. E. Schall:—The gentlemen gave an idea of what a bridge might be put to. The life of a bridge does not so much depend on the light loads as the over-stresses.

THE CONSERVATION OF MATERIAL

By G. W. Andrews*

It is probably not generally known that the pig iron situation today has become a very serious one, in fact, such that the amount available is only about sufficient to provide for war requirements. This being true, it has become necessary for our Government, through the War Industries Board, to formulate and issue certain rules prohibiting the use for all purposes possible of all materials in which pig iron enters into the production. This, of course, takes in all steel and iron products of every character.

In view of the above condition, the use of cast iron and steel pipe has practically been prohibited for the period of the war, for any purposes where brick, stone, concrete pipe, vitrified clay and wood pipe can be substituted. Knowing as we do the great value of cast iron, wrought and steel pipe, we have been prone to lean toward its use even where it was possible to substitute other materials.

There is absolutely no reasonable excuse for using at this time, metal piping of any character for drainage and sewer or culvert uses on railroad work. For drains under tracks, I do not believe we should ever install anything smaller than a 12 in. opening and for this purpose we should use 12 in. by 12 in. wood boxes made of lumber 2 in. thick and treated wherever practicable. When greater openings are required we should go to 18 in. to 60 in. vitrified clay or reinforced concrete pipe. For underground drains of small sizes, we should use vitrified clay pipes, and where necessary, cover them with concrete. I am fully aware that this does not comply with community laws, but as previously stated, the use of steel or cast iron pipe will be prohibited, and there will be nothing for the communities to do but fall into patriotic line and consent to waive iron clad requirements.

For certain water lines, especially long supply and gravity lines, serious consideration should be given to the use of wood stave pipe. I have recently made a close study of the use of this type of pipe with the result that an order has been placed for 9000 lin. ft. of 8 in. pipe for use as a gravity line connecting high and low pressure reservoirs.

The use of steel, either in supports or water storage tanks, must be discontinued during the period of the war, and timber or concrete substituted. As a matter of economy, the writer's favorite practice of placing from 4 in. to 6 in. of concrete on the bottom and a few additional hoops between the regular lower hoops, should be given serious consideration, not only during the present trying period, but for the future. It will probably be asked what effect this has on the top of the staves. The answer to this is, none. I believe that nearly, if not all of our members, will agree with me that our greatest trouble with leaks is either around the chimes or at the top of the staves. The cement bottom and additional hoops will take care of the chimes and, in many cases, the lowering of the float valve a few inches will take care of the top. Where holes appear on other parts of the staves, they can very often be remedied easily by clamping a piece of 1 in. or 2 in. stuff on the inside. Details have been entered into to fully impress on all concerned the necessity of conserving wherever possible, in the care and maintenance of tanks.

There is no work handled by bridge and building forces, in which

* Assistant to General Superintendent Maintenance of Way and Structures, Baltimore & Ohio Railroad.

the necessity for conservation does not enter. For buildings we should discontinue, especially on outlying stations and other small structures, the use of large glass in the windows, substituting wherever possible, sash with small glass, not larger than 12 in. by 14 in.

In painting buildings and bridges, there is unquestionably a great waste in brushes, in many cases the foreman permitting them to remain in the paint cans until they are valueless. It should be the duty of all foremen to see that all used brushes are kept in a softening liquid and in condition for use until they wear out. Receipt should in all cases be taken from each man for dusters and putty knives furnished and these should be returned at the end of the job or on the laying off of the men.

Gutters as well as down spouts on line or road stations, freight houses, etc., can in many cases be made of wood instead of metal. The life of roofs can be prolonged materially by judicious and proper painting, and even when filled with pin holes they can be preserved by the application of a good roofing cement in paint form.

Water supply offers considerable food for study. More time should be given to the proper training of our pumpers in the proper method of firing their boilers, oiling of pumps, running repairs, prevention and wastage of waters, and the plain exercise of common sense in handling their work.

On timber structures, it will always be necessary to take out timbers of which a large percentage is good. They can often then be used in the same structure for shorter members, but where this is not practicable they should be sent to the company's saw mill for reclamation.

All bolts, packing spools and washers should be saved and where necessary, bolts recut. Any railroad of large mileage that has not established reclamation shops, must certainly feel the need for them at this time, especially in bridge and track work. The company with which I am connected has had such shops in operation for a number of years, and they have proven an economical proposition in the best of times, and a blessing at this time.

In our bridge, frog and switch shop we are at the present time turning out necessary materials, especially bridges, that would be out of range of possibilities to obtain. Let us remember that we must stop and think before ordering new material, no matter how small the item, that it might be possible to substitute for something else. Permit nothing to go into the sale scrap pile that can be used. First of all, train your men, especially foremen, to follow along these lines.

SMALL VERSUS LARGE GANGS FOR MAINTENANCE WORK.

COMMITTEE REPORT

This subject is one that admits of a wide variation in ideas and is one on which much can be said against either small or large gangs. In my opinion the success of either rests with the foreman and his ability to lay out the work and arrange the details so that neither confusion nor discord is permitted to arise.

A close observation and study of men in charge of gangs discloses three classes of foremen: (1) A man who can handle two or three men to good advantage and keep them busy, but whose efficiency as a foreman ceases when he gets more than this number: (2) the man who is capable of handling a large crew of men on a large job but who is "at sea" on a small one and, (3) the man who is the happy medium between the first and second and has the foresight and ability to lay out and arrange his work so that he can keep all his men busy, whether the job is small or large. I believe that a crew composed of a foreman and five to seven men is preferable to a larger one for general maintenance work and that the work is done more efficiently and economically. Take the gang stationed at the average terminal where the men may all work at the same job from one to several days at a time and then be spread out for days at a time with not more than two men working together. Then it is that the foreman has his hands full to look after them to see that the work is done properly and that they do not lack for material. Here is where the small gang is preferable to the larger one from an economic point of view, as it gives the foreman more time to oversee the work. At the same time we all realize that the closer the supervision the better will be the results obtained.

A road gang should have about the same number of men as a terminal gang for various reasons. Take for example a job of renewing bridge ties or cutting off piles and putting on frame bents. A gang of from 6 to 7 men can work to good advantage without getting in each other's way and can accomplish practically as much as a larger crew on the average job of this kind, especially where the traffic is all heavy. The framing can be done while waiting for trains, and timbers can be put in after trains have passed, where if too many men are working the framing can be done faster than the timbers can be used, making it necessary for the men to be idle a part of the time.

On building work we have many jobs on which it is very difficult to keep even six or seven men employed to good advantage. This is where a foreman can show his ability by keeping a close watch on the progress of the work being performed by each man noting how soon he will be through with his present task and then having another ready. Again small emergency jobs turn up at points distant from where the gang is located which requires the service of from one to three men. While this work is in progress there are usually minor repairs at other points to be taken care of which the foreman can have done by other members of the crew so that the whole gang is working to advantage. I believe the average foreman plans his work when he goes to a job and organizes his forces accordingly. If a large gang is employed, when these small and emergency jobs come up and he has to send a part of the gang away it disorganizes the entire force and good results cannot be accomplished.

J. P. Wood,
Chairman.

DISCUSSION

(Small Versus Large Gangs)

R. H. Reid:—I think the report covers the ground pretty well. One point might perhaps be mentioned to bring out a little more clearly the idea that for ordinary maintenance and repair work a small gang will perhaps serve the purpose more economically than a larger gang; for construction work and especially iron construction work, usually a larger gang is necessary, especially in the case of the erection of truss bridges. Ordinarily a small repair gang can work under the division engineer or the division forces but as a rule the larger gangs on construction work are more transient. They are so-called floating gangs and move from place to place where the larger jobs are under way. For those cases I think the larger gang is preferable but in my experience I have found that for ordinary repair and maintenance work the small gangs are more economical as they lose less time. On heavy iron construction and erection work a small gang cannot make any headway at all. They are not able to handle the pieces. You need a large gang for that.

J. P. Wood:—In getting up this report I referred to general maintenance work. I realize, as Mr. Reid says, that where you have larger jobs they require a larger force of men.

The Secretary:—A great deal depends on local conditions and more particularly on the importance of the job. If one encounters a large emergency job which must be done in a hurry he must necessarily arrange for a large crew or double up several small ones. As a general rule, on ordinary maintenance work, small crews can work to better advantage in many respects.

J. Dupree:—It has always been my policy to assign my men their work the night before they are supposed to do it. Two fellows may be painting, two other men may be putting in pipe. I don't wait until 7 o'clock in the morning to tell them what they are going to do that day but I have it all mapped out and fixed in their minds the night before so they can think it over while they are eating supper and during the evening. To be sure, we are only working eight hours now but that does not make any difference. A good foreman will work out his salvation the night before.

R. C. Henderson:—I think it all comes down to the question that the secretary brought up. They give us the work and it is up to us to place the gang where the men can do the most good

and work to the best advantage. If we have work enough to keep 10 men busy under one foreman in a certain territory, it is the proper thing to use 10 men. I think sometimes we might get a little more work done and more economically by having two gangs with five or six or seven men in a gang, but the chances are, in the majority of cases that one will get more done by having a few men than a large gang.

T. B. Turnbull:—Our railroad is a small railroad and has only a couple of bridge gangs, one or two building gangs and a dock gang; the largest of these gangs comprises seven men including the foreman. If anything heavier than that comes up we have to double them up. The building gang runs as small as four men. The only question, of course, is the overhead expense. Most of these gangs nowadays insist on having a cook. Then if you give a gang of seven men a cook, the gang of four wants a cook also. I was wondering what the rest of the railroads do in the matter of cooks and how large a gang they have before they install a cook.

W. E. Alexander:—We have had many very small crews. I approve of the report that we have before us. We do not want crews too large. The proper size depends on the job we are at. When we are on a large job we want a gang large enough to handle it but on repair work it is a great mistake to have men in each other's way. We want good men and plenty of work for them to get the most done and the best results. We want enough men, however, to do the job in hand. This does not take as many in a crew as people sometimes think.

It has been our custom to have, when we could, what would be called a repair gang of 8 or 10 men including a cook and foreman. From 6 to 8 men besides the cook and foreman makes a very good repair crew for general work. Even less than that on some jobs is better; but when we have less than that we usually send out a few extra men where there is extra work coming up to be done.

The question of cooks has been raised. We have several repair gangs on the road all the time, usually consisting of 5 or 6 men besides the foreman and cook. Then we furnish a good outfit and a good cook. The foundation of a successful crew is a good cook and plenty to eat. The company furnishes the cook and the men furnish the outfit with dishes, clothing, bedding, fuel and a stove, each man paying his share for the food which he eats. They

are charged their board and settle among themselves the amount due from each so the company does not bother about boarding them. Under such conditions we find we can get men better than we could before. Like all other roads our wages are low and we cannot hold good men when somebody else wants them. We had had good bridge men and we lost them. We had good carpenters and we lost them because somebody else could pay them more. We finally got down to where we had only the minimum wage and the minimum ability that went with it. When the wages were raised our efficiency was raised accordingly. However, this has been changed with government management. We are doing better than we had ever done before and our men are working with better heart,—doing more work in the same hours than they did before. We are getting men enough to do our work, but we expect that. We do not have large crews and we do not want them. The greatest trouble with us is to keep our men employed in the winter. We've got to hold our good men then. Sometimes we have extra jobs coming on through the winter and I am glad to be able to keep our men for that. We waste a good deal of time in winter with short days, cold weather, and snow, but we must have some men to keep up the repairs during the winter, so it is more of a problem with us than it is with people further south.

R. H. Reid:—Referring to Mr. Alexander's remarks about taking care of the men in winter I think it is well to provide for the winter work during the summer, to arrange the schedule of work during the season so that the urgent work that must be done in warm weather can be done in the summer and iron work, riveting, etc., can be done in winter as well as in summer.

LABOR SAVING DEVICES

COMMITTEE REPORT

It is a long time since we have heard the old argument that labor saving devices deny the working man his chance of making a living. Even before the present conditions brought about such a scarcity of man power, the value of such devices was fully demonstrated, but there arose frequently the question whether machine or man power was more economical. Today we are facing a situation that is entirely different and the question is almost entirely one of saving labor, or, rather, how can so much work as we have to do be done with the men available?

It has always been a noticeable fact that the more an industry has adopted labor saving devices the more rapidly it has developed, and this development has not been due alone to the devices but also to the planning and organization of the work. The man in charge of the work, whether superintendent, supervisor, foreman, or whatever his title, is the first factor in the problem of saving labor because much depends upon him. It is his part to plan the work so that each operation can be accomplished to the best advantage. Each man is assigned to the work for which he is best fitted and the men are so grouped that the various operations can follow each other systematically and also so as to avoid having men in each other's way or waiting for each other. In planning the work, a foreman should avoid putting too many men on any one part of the work because if they are congested they will not accomplish as much and there will be much idle talking. Men will work best in teams, and if some plan of competition can be instituted, the results will be better. Work should also be planned so that skilled workmen do no unnecessary walking in getting at their tools and materials.

The material arriving at a job should be so unloaded and placed as to avoid unnecessary re-handling. Laborers should be employed to bring the material to convenient places for the skilled workmen. Tools are to be kept in usable and safe condition and returned to proper places at night in tool boxes and tool cars.

The heavier work of the Bridge and Building department is usually quite well provided for, because every railroad has as part of its equipment, pile drivers, locomotives, trains, derricks, and other machinery for doing heavy work. Such equipment is provided as a matter of course. The conditions prevailing during the last few years have brought about an unusual interest in the smaller machines and tools that permit the available force to keep up its maintenance and construction work. No argument is now needed as to the value of such devices, but the question is rather—what can be had and how can it be applied?

The motor car for the transportation of men and material is accomplishing great results. Through its use men are carried to their work with the least expenditure of time and arrive at the job physically ready to go to work. It enables crews to go longer distances from their outfits, and because of this, outfits have to be moved less frequently, thereby saving train service. The push car is loaded with material and hauled as a trailer and material is handled much more expeditiously in this way than in the old manner. It is true there have been some accidents in the use of motor cars, but as the men become more experienced in their use these are less frequent and they may be avoided altogether by the use of proper precautions. Motor cars and push cars should not be used on the main line without knowing that the track is clear. The loading of the cars should be watched carefully by the foreman. Material and tools carelessly loaded may drop off and cause derailments, or con-

siderable loss in time in going back to pick them up. If material is of such a nature that it is necessary to have it project at right angles to the track great care should be exercised in seeing that it will not come in contact with traffic on other tracks or with switch stands, etc.

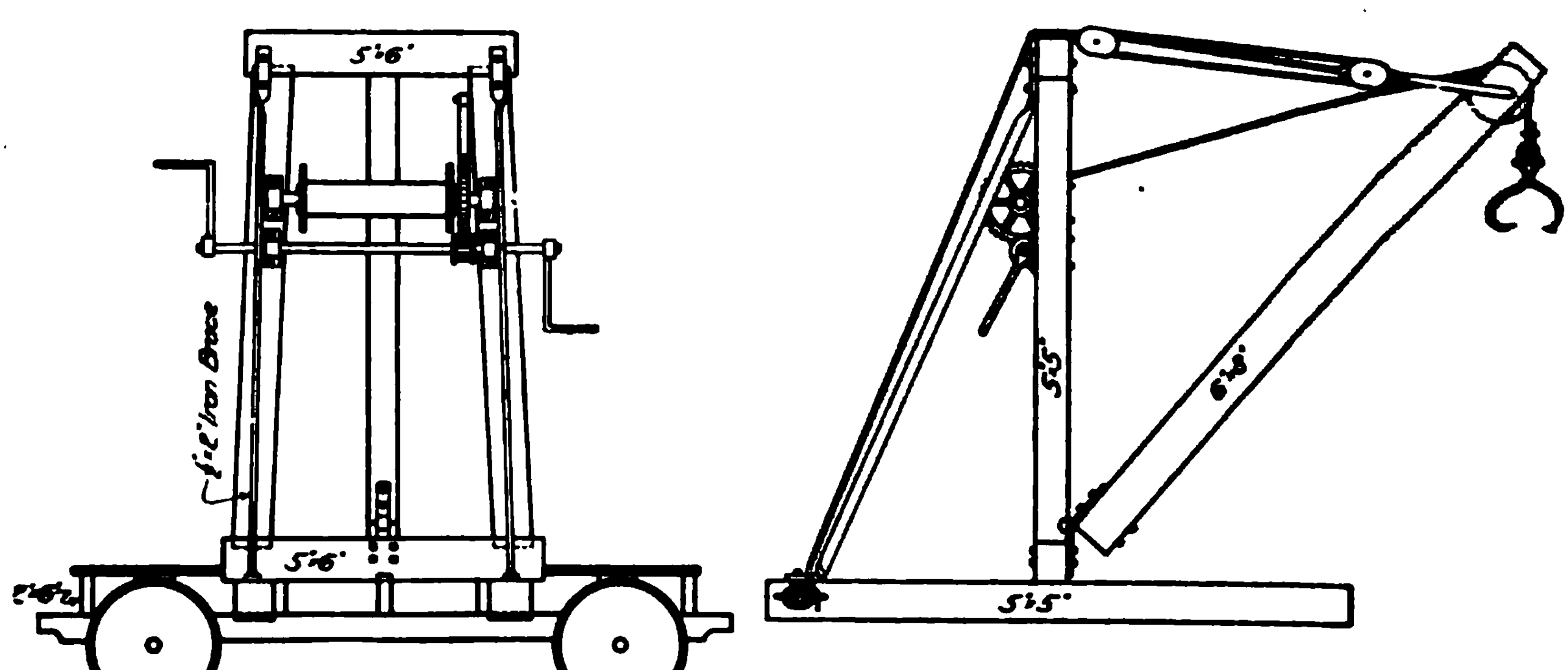
The concrete mixer is another device which has brought about much saving of labor and is now manufactured in so many different sizes and forms that all classes of work can be taken care of. The smaller portable outfits are economical for use on comparatively small pieces of work and the larger outfits, in conjunction with hoists and conveyor belts and other devices, are proving very effective on large construction work.

The gasoline engine is another device that has effected much saving in labor. It is used in conjunction with motor cars and concrete mixers before mentioned, and, in its various forms, can be adapted to many operations on maintenance work, such as running pumping machinery, hoists, small pipe saws, etc.

The manufacturers have placed on the market a variety of tool grinders, with numerous attachments, that make them almost an indispensable part of the working outfit and their value is self-evident.

Hand derricks or cranes can be used most effectively for lifting and placing heavy timbers and other heavy material and have proven themselves very effective when mounted on push cars. The Northern Pacific has in use a home-made hoist mounted on a push car which is very simple of construction and easily manipulated. A frame of 4-in. timbers bolted to the deck of the car carries an old hand car gearing on the gear axle on which has been placed a 10-in. oak drum. Through the frame at right angles to the track and projecting on either side is run a 6-in. by 10-in. timber blocked up on one side of the car and bolted to the floor on the other. Two 6-in. sheaves are fastened at the upper end of the timber and a rail clamp with a chain at the lower end is used to prevent the car from overturning. With this device two men can pick up a stringer from the embankment at the end of the bridge, swing it clear, run it out on the bridge and lower it on the end caps, ready to be put in place. The device has proven very efficient and practical. The Southern Pacific has a light steel derrick mounted on a push car which is used for similar work. The Chicago, Milwaukee & St. Paul Railway has similar home-made devices installed on push cars which will enable two or three men to accomplish work that formerly took from six to eight.

F. E. Weise,
Chairman.

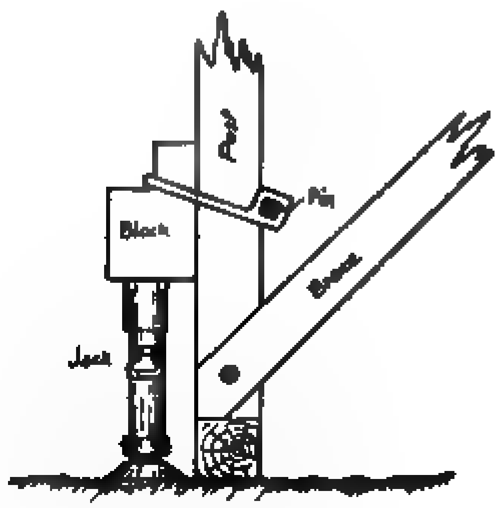


Hand Car Derrick, Chicago, Milwaukee & St. Paul Ry.

Derrick Anchored to the Rail, Loading an 8x16 Stringer,
N. Y. N. H. & H. R. R.

Hand Derrick, Labor Saving Devices

Hand Derrick, Labor Saving Devices



Simple Toggle for Jack, B. & O. R. R.

DISCUSSION

E. E. Candee: (by letter) I am using a contrivance on the New York, New Haven & Hartford that would come under this head which consists of a push car with a Jinniwink derrick and a hand crab mounted on its deck for putting in stringers, caps and heavy posts, unloading heavy timber from sideboard cars, setting light structural steel,—and in fact for any purpose where it is desired to lift not over one ton and is not practical to use a steam derrick.

The dimensions of the car and derrick are as follows: wheel base of push car, 8 ft. Deck extends 1 ft. past the forward axle and 2 ft.-6 in. over the rear wheels, making 11 ft.-6 in. over all. Shear legs of the A-frame are 8 ft. long. Boom, 22 ft. long. Crab sets over rear axle.

The car is anchored to the track when in use by rail clamps connected to the body of the car and when thus clamped to the rail the load can be swung out at right angles from the track for a distance equal to the length of the boom. The outfit is taken off the track when not in use by means of a small turntable, or jigger. Three men can place the car on the track ready for service or remove it in one minute. In a test taken when the car was first put in service, it was put on the rails and four 8-in. by 16-in. by 24-ft. stringers were loaded in 4 minutes. The outfit with its load of stringers was pushed out on the bridge, the 4 new stringers placed and the old stringers loaded in 10 minutes. While the track was being lowered the old material was taken on shore and placed on a pile by 3 men and a foreman (with one man lowering the track) the outfit being removed from the track in 6 minutes, making a total of 20 minutes to place 4 stringers on the bridge with the foreman and 4 men doing the work. No man did any lifting or straining as would have been the case if stringers were put in the old way.

The derricks that I have in use were built by my bridge men on days when the weather would not permit them to do outside work. I do not think too much can be said in favor of these little derricks for bridge work; for they not only make it possible to do heavy bridge work easily, but quicker and with fewer men. With this outfit 6 men can do more work in less time than 8 men can do without. We operate them on a trestle where 18 passenger trains pass between 7 a. m. and 6 p. m., besides a large number of freight trains and switching movements and never have to hold an extra over 10 minutes. If the same work was done by hand it would be almost impossible to do it without holding trains one-half hour or more.

FACTORY-MADE REINFORCED-CONCRETE PRODUCTS*

By Charles Gilman

The purpose of this paper is to describe the salient features of reinforced-concrete products as applied to railway work, with special reference to those that are made in a well-organized and equipped plant and which, for the sake of brevity, will be styled "factory-made." It is also proposed to show how the development of the factory-made reinforced-concrete product has solved many of the construction, maintenance and economic problems of railway engineering. The merits that determine the adaptability and efficiency of any construction method from the point of view of a railway engineer, and that are distinctly characteristic of the factory-made concrete product, are the following: Permanency as regards both dependability of service and lasting qualities; availability of products to point of installation; portability of products to facilitate transportation and handling; minimum interference with traffic; reduction in the use of motive power and rolling stock for construction purposes; minimum amount of labor used in the field; ultimate economy.

Concrete Pile Trestles

The first example of factory-made reinforced-concrete products to be considered is the concrete-pile trestle, the development of which began about 1906 by the late C. H. Cartlidge, who was for many years engineer of bridges of the Chicago, Burlington & Quincy R. R., and who is considered the pioneer in the use of factory-made concrete piles and slabs in railway work. In a report on "Reinforced-Concrete Trestles," presented before the Western Society of Engineers, April, 1910, Mr. Cartlidge summed up the results to be attained in the following words: "An investigation of the reasons for the great economy of such a construction as the pile trestle shows that it is largely due to the small amount of work necessary to be done in the field. There are no coffer-dams, foundation pits or falsework to be built. Very little raw material has to be unloaded and cared for. The members composing both the substructure and the superstructure are taken out and put in place very largely by machinery with a minimum disturbance of track and delay to traffic. It was evident that if a construction of permanent material having the characteristics mentioned could be devised, the result would be what was wanted."

To meet with the conditions mentioned by Mr. Cartlidge, it is necessary to obtain the maximum efficiency of concrete and steel so as to reduce the weight to a minimum. The reduction of weight is brought about in the design of concrete piles by providing definitely designated points at which the hitches for handling are to be made. The reinforcement can be increased at these points to take care of the stresses developed in handling, rendering it unnecessary to provide for a cantilever action for the entire pile when handled promiscuously. It has been found that piling 50 ft. in length can be economically designed to be handled with one hitch made one-third the way from the butt end; for longer piles, additional hitches should be provided for. The drawing shown (Fig. 3) indicates the general dimensions and system of reinforcement that has been found to produce a very economic type of piling for railway trestles. This pile is calculated to take a working load of 25 tons with a maximum column action above ground of 20 ft.

The concrete slab, details of which are shown in the illustration, (Fig. 4) should be designed to provide for easy handling. Two slabs are used for one panel of a single track bridge, as they can be placed

*Reprint from American Concrete Institute, Vol. 14, 1918.

Fig. 1.—View in Yard Where Concrete Piles Are Being Made

with less interference to track and traffic and less derrick power than one slab for the entire width of the bridge. A trestle for one track is from 13 ft. to 15 ft. wide, according to the various railway standards, so that each slab would be 6 ft. 6 in. to 7 ft. 6 in. wide. The length of slab can be standardized to a large extent and still make an economical span. It has been found in practice that spans 14 ft. to 16 ft. from center to center of bents produce the most economic structure for trestles of average height. Lifting stirrups are used for handling and are placed so as to balance the slab transversely. Auxiliary reinforcment is placed in the region of the stirrups to carry the stress that is transferred to the upper surface.

The compact organization of a centralized permanent plant that is possible under the factory-made method renders it practical to make up large quantities of piles and slabs ready for use when needed. When a bridge is up for renewal, the length of piling required can be determined either from the record of piling already driven in former structures, with

Fig. 2.—Type of Trestle Built from Factory-Made Units

due regard for the difference in the sectional area of these piles and concrete piles, or by the use of test piles. The usual procedure in the construction of a trestle is to send to the site of the work a pile-driver, generally of the derrick type, with the piling required. This type of driver can be sent either in a work train or in a revenue train, and, having self-propelling facilities, can unload piling, release cars and do the driving without requiring a work train to handle it. As it is usually the custom to work from the old structure that is to be replaced, this driving can be done with the least interference with traffic and without slow orders. After the piling is driven, a small masonry gang casts the caps in place. When the caps have seasoned sufficiently, the slabs are unloaded and set with the derrick. The placing of ballast, the substitution of track ties for bridge ties and the clearing up of the site by the derrick complete the entire construction of the bridge. By comparing this method with the handling of large quantities of raw material, labor, camp equipment,

construction equipment and changes in the old structure, or the construction of falsework and the maintaining of slow orders, with the resulting delay to traffic, it can be readily seen that from a railway point of view the factory-made method as applied in this case permits the construction of a fireproof trestle of maximum permanency and ultimate economy.

Culvert Pipe

All railway officials owe a great debt of gratitude to Mr. Cartlidge, not only because of the concrete pile trestle, but also, and to a greater degree, because of the adaptation of reinforced-concrete pipe to railway requirements. In 1906, Mr. Cartlidge was confronted with the necessity of replacing many of the original wooden box culverts on the C. B. & Q. R. R. After making a considerable study of the materials available and their relative cost, he decided on the factory-made concrete pipe. In casting about for a design which would be economical and safe as well as distinctive he came across the method of reinforcement which provides for a single line placed in the region of tension throughout the pipe. Instead of distorting the reinforcing cage to place it in the region of tension—which is necessary when using this system in a circular pipe—Mr. Cartlidge left it in repose and changed the contour of the pipe section by inserting, between the upper and lower semi-circles of a circular pipe, tangent distances equal to the thickness of the walls of the pipe. This enabled the reinforcement to take the desired position and still be in repose as a circle. In casting the pipe, the ends of the long diameter were marked "Top" indicating that the long diameter was to be placed vertically—the position of maximum strength. This unique design not only produced a pipe of adequate strength and increased flow area, but also afforded an opportunity of proper inspection during and after installation.

In 1907, Prof. A. N. Talbot, of the University of Illinois, made a series of tests on the Cartlidge design of concrete pipe, as well as on cast-iron pipe and other forms of concrete pipe, the results of which were published in Bulletin No. 22 of the University of Illinois. The publication of this report cleared away any uncertainty which existed in the minds of engineers as to the ability of a properly designed and manufactured concrete pipe to successfully carry railway loads and gave the industry the desired impetus.

Since 1906 other designs of concrete pipe have been developed and used on railways. The most common of these is the circular pipe reinforced either with a single line all in the region of tension or two concentric lines. To take care of conditions where a pipe of minimum headroom with adequate area of flow is required, a flat base pipe has been designed, the upper section of which is a semi-circle and the invert a curved surface of large radius. This section has the necessary strength, requires practically no foundation under it, and provides a good flow. A design of triangular section has also been developed and used to some extent for low headroom conditions. While this pipe has considerable strength, and requires a small amount of reinforcement, it is very heavy on account of the thickness of the walls and has a small flow area.

In designing a culvert pipe, due consideration should be given, on account of handling, to the weight per section by properly proportioning and placing the steel in relation to the thickness of the wall. A culvert pipe should have sufficient strength to carry the usual railway loads with a generous factor of safety so that when subjected to unusual or sudden loads it has the ability to resist. Experience has shown that a concrete culvert pipe should have bell and spigot ends, to give the necessary strength and stiffness at the joint to hold the culvert to grade and it should also be of such a length that it can be loaded, unloaded and installed economically.

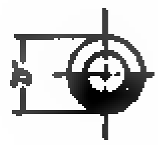


Fig. 5.—Schedule of Concrete Poles Held in Stock

Grade Elimination

G. E. Tebbetts, Bridge Engineer of the Kansas City Terminal, has worked out a very interesting type of factory-made concrete in connection with the numerous subways and highway bridges that were constructed in Kansas City during the past few years. At first, the abutments, pier foundations, piers and girders were cast in place, using slabs built under the factory-made system. It was then considered feasible to make the girders as units and install them later. A further development included the columns. It is therefore possible to see, in Kansas City, subways showing the gradual development of the factory-made concrete until now only the abutments and pier foundations are cast in place.

This type of construction has reduced to a very noticeable degree the interference with both railway and street traffic, the time of construction and the ultimate economy of the entire work, to say nothing of obtaining all the advantages of factory-made concrete that have been discussed elsewhere in this paper. The possibility of inspecting each unit of a structure before it goes into service, with the minimum interference of traffic during erection, has made this type of construction very attractive to railway engineers.

Where streets cross over railways, this same type of unit construction can be used. A design for this particular purpose has been worked out very effectively by A. B. Cohen, Concrete Engineer of the Delaware, Lackawanna & Western Railroad. It is especially effective where the decks of bridges having stone or concrete abutments in good condition require renewal. The use of factory-made beams, girders and hand rails has reduced the field work to a matter of a few hours. Where new foundations for columns or new abutments are necessary, they can be installed without interfering with railway or highway traffic, and the columns, girders and slabs can be set in place by work trains in a surprisingly short time.

Houses

Railway systems require many small houses that should be fireproof, ratproof, portable, sanitary and reasonably safe against malicious damage. The various types used include telephone booths at passing sidings, watchmen's houses at grade crossings, block stations, oil houses, houses for torpedoes and fuses, outhouses, pump houses, scale houses, motor-car houses, transformer houses and cable-test houses. The factory-made product has fulfilled all of the above requirements at a reasonable cost. With the increased use of the factory-made product, it has been possible to standardize many of the types, justifying the expense of steel forms, the use of which has produced accuracy and economical production. To-day, the only limitation of the size of houses that can be made in the factory is determined by railway clearances. Particular attention has been given in the design of these houses to permit handling by derricks or by skids. Usually, the roof and its connection to the side walls are so reinforced that a timber under the ridge pole or at the base of the roof fastened to a line through the ventilator or chimney hole will permit handling with a derrick. In most cases the matter of foundation can be taken care of with a bed of cinders or gravel. Where it is necessary to install heavier foundations, particularly where the ground is soft, or to make up for the inequality in the level of the ground surface, as on the sides of embankments, pedestals can be installed at small expense.

Manholes

The construction of underground conduit work by the telephone, telegraph and signal departments of railways has in many cases been materially benefited by the use of portable concrete manholes. Instead of building expensive brick and concrete work in place, which must be pro-

tected from the vibration of passing trains in order to season properly, it is possible to place the factory-made product with a derrick in holes which are prepared just in advance of the installation. This reduces to a

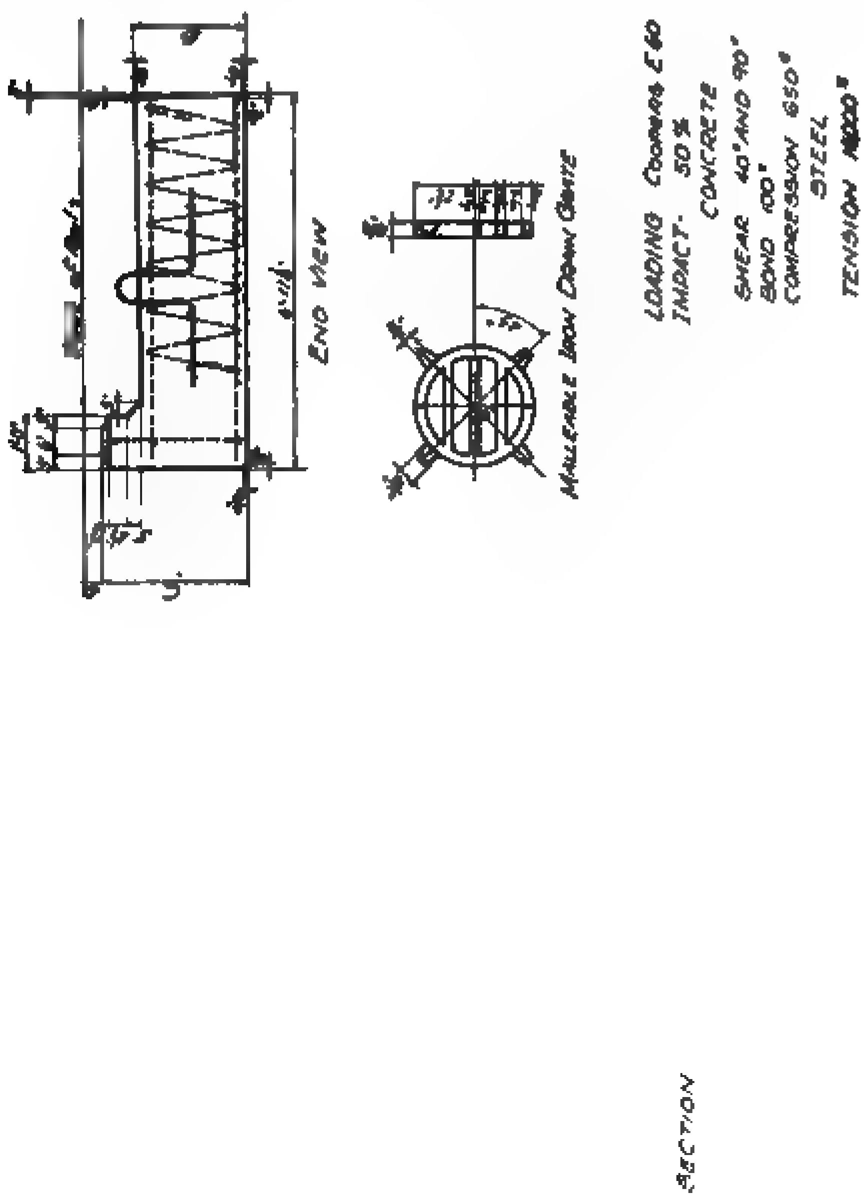


Fig. 4.—Reinforced-Concrete Bridge Slabs

minimum the time necessary to keep excavations adjacent to the track open, and consequently slow orders. The use of the factory-made manhole has produced not only a permanent, waterproof structure, but it has also materially reduced the cost.

Battery Boxes and Wells

The high cost of metal with its tendency to corrode, and the short life and instability of timber, have created a demand for a more stable material for battery boxes, wells and chutes for the signal department of railways. The necessity for a receptacle that is waterproof, frost-proof, portable and of permanent construction, which properly protects storage and primary batteries, has been completely met by the use of the factory-made concrete product, and today this product is a standard on the railways of this country.

Poles

With the decreasing supply of suitable material for wooden poles for telegraph and telephone service, the various railways in the country have been casting about for an adequate substitute. A number of short lines have been constructed with solid reinforced-concrete poles, within the past five years. These, however, have not proven satisfactory on account of their weight and cost. Recently, a machine has been developed by means of which a hollow concrete pole can be produced by centrifugal methods. With this machine a pole can be made of any desired length and taper, and the thickness varied to meet the load conditions. The density produced in the concrete by the pressure of this centrifugal force is remarkable. A pole thus made has sufficient strength to meet storm conditions, is not affected materially by the elements, is light in weight, permitting ease in handling, has a pleasing appearance, and is low in first cost. In addition to the requirements for telegraph and telephone service, these poles can be used on railways for station lighting and signals of all types.

Miscellaneous Products

In the foregoing, an attempt has been made to show the application of those concrete products in general use. Other products in concrete have been used as substitutes for timber, cast iron and steel, such as posts for right-of-way fences, hand rails for viaducts and retaining walls, pipe-carrier foundations for interlocking plants, warning signs, smoke jacks for engine houses, boot tanks for grain elevators, cribbing and crossing planks.

Where the Products Are Made

The first plants for the manufacture of concrete products for railways consisted of a siding, a derrick within range of the siding, a platform around the derrick on which to set up the forms, a mixer within the radius of the derrick so that it could fill the forms, an industrial track on which was operated a car to transport the green product to the adjacent seasoning yard, a cement house, and cage shed. No attempt was made to operate these early plants during the winter, the plan being to manufacture as much product during the warm and fair weather as possible and shut down for the winter. The output of such a plant was further limited to the speed of the derrick which was used to unload raw material, set up and strip the forms, pour the concrete into them, and load the finished product.

As the demand for the factory-made product increased, it was found necessary to operate part of the winter, at least, on days when the weather was favorable. For the manufacture of pipe this was made possible by the introduction of small steam rooms within the radius of the derrick. These rooms were large enough to hold a number of pipes and had removable roofs so arranged that they could be handled easily with the derrick. It was customary to build these houses in groups of three, so that only one at a time was open each day for casting, while the other two contained pipe seasoning under steam. In the case of battery wells, boxes and houses, a separate building was erected for their manufacture. This

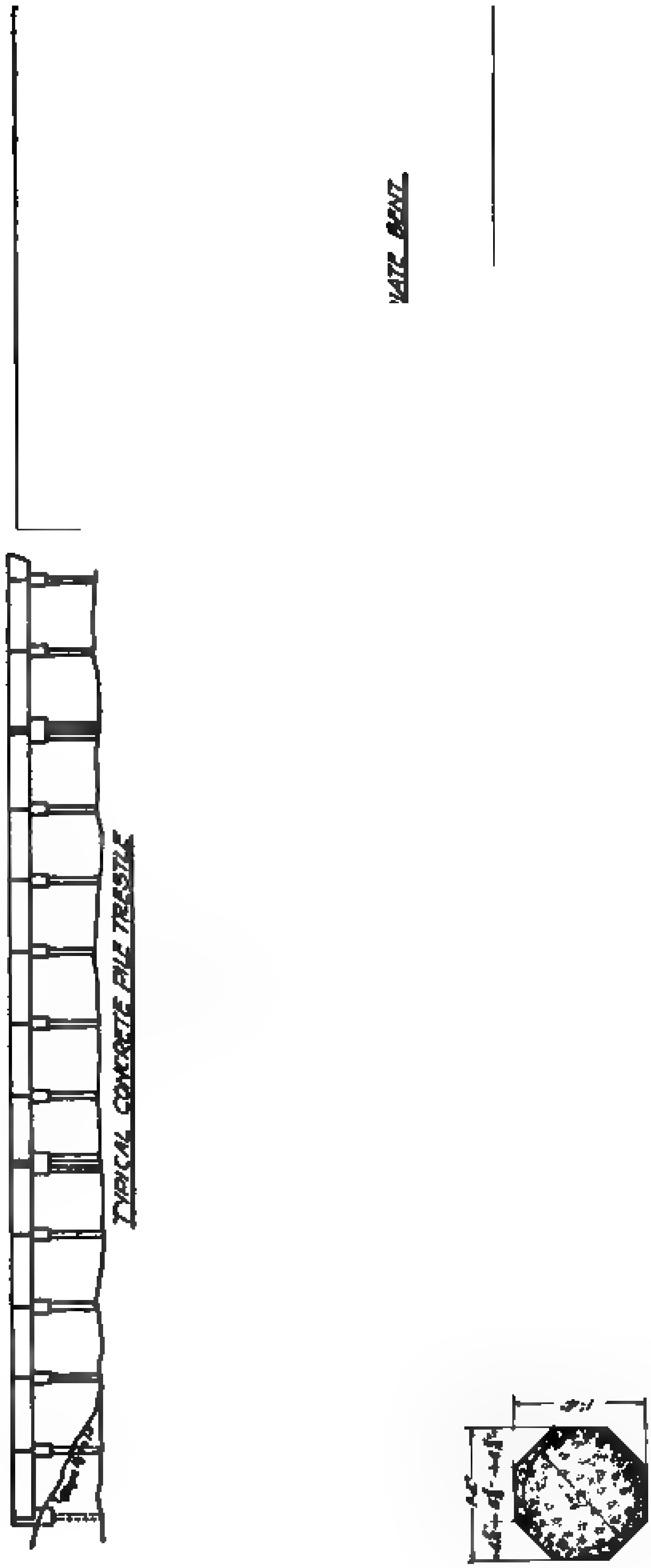


Fig. 3.—Piles and Trestle Bent for Standard Construction

was usually a one-story structure, with a concrete floor and some means of heating. As these products can be handled with a large horse on wheels, this building was placed beyond the range of the derrick but near enough so that the finished product when wheeled outside the building could be loaded out by the derrick.

Fig. 6.—Standard Sizes of Reinforced-Concrete Railway Culvert Pipe

With the further development of the industry, it became necessary to design a p'ant for continuous operation and large capacity. Today, a modern plant for the manufacture of concrete pipe consists of a long one-story building equipped at one end with an elevated hopper for sand and

Fig. 7.—Lifting Precast Railway House

Fig. 8.—Concrete Pipe in Stock Yard Awaiting Distribution

gravel, filled with a derrick and clam-shell bucket. The mixer is also elevated and is placed directly under the gates of the hopper so that the operator can control the flow of sand and gravel easily and quickly. The house is equipped with a number of parallel tracks with two transfers—one in the rear and one directly in front of the mixer. The forms are set up on platform cars which are pushed up to the mixer, filled, and then pushed down another track to the steam room. In the middle of the house is a stripping tower equipped with electric hoists and chain blocks for stripping and setting up the forms. In the rear of the plant is a derrick for removing the pipe from the cars to the seasoning yard. The cement storage room and the cage room are located inside the main building. Such a plant can run 24 hours a day throughout the year and has a large production.

In addition to the pipe house, a modern plant has a building for the

Fig. 9.—Type of Large Precast House

manufacture of wells, boxes, manholes, houses, posts and smaller products. It also has a pile yard for the manufacture of concrete piles and slabs, which is usually a level strip of ground adjacent to a piece of straight side track. The equipment necessary for manufacture of piles and slabs consists of a mixing plant, forms—preferably of steel, foundation timbers and pallets to support the forms and a locomotive crane for setting forms, casting, and loading the seasoned piles and slabs. For the manufacture of the hollow concrete poles a separate building is required with a mixing plant and an overhead crane for handling the raw material and the finished product. From the foregoing it is seen that the present tendency in plant construction is to obtain uninterrupted production and protect the product and the labor from the elements which results in more and better product.

In conclusion, the foregoing may be summed up as follows: With the use of the factory-made reinforced-concrete products, the uncertainties of

Summary

other methods of construction can be eliminated and the amount of labor, equipment and transportation greatly reduced. The delays due to weather conditions, dependency on migratory labor and the necessity of maintaining traffic, regardless of construction economies, are largely eliminated. The centralized and thoroughly trained organization of the factory permits a thoroughness of inspection during all stages of production that prevents, as far as possible, a failure after installation. The work in the factory can progress continuously without regard to climatic or other conditions, making it possible to carry a stock of finished, seasoned product at all times. By taking the finished product from stock, a definite program for installation can be arranged and carried out. The thoroughness of workmanship that is possible in the factory results in a quality of

Fig. 10.—Hollow Concrete Lighting Standard

concrete that can be depended upon to meet designing requirements with a maximum degree of certainty. The great density of concrete, when properly proportioned, mixed and thoroughly seasoned, such as produced under factory methods, permits the use of higher stresses than ordinarily assumed.

It is often necessary to use large factors of safety or low stresses to guard against the possibility of poor concrete in certain classes of field work, due to the prevalent use of local material, an unreliable supply of water as regards its purity and the inability to maintain thorough inspection. These conditions of course do not hold true on field work in general, but they can be eliminated more completely by the factory system than by any other. The high grade of concrete obtained by the factory methods justifies the use of a higher percentage of reinforcement with a result that sectional areas can be greatly reduced. Experience has shown that it is economically feasible to eliminate cast iron, steel, timber and other material subject to deterioration from many construction projects where formerly these materials were considered indispensable.

Today the use of the concrete product in preference to these other materials is of most importance in that the ingredients of the concrete product and the labor necessary to produce it do not interfere with the production of war materials.

Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Colo.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428
21	St. Louis, Mo.,	Oct. 17-19, 1911	499
22	Baltimore, Md.,	Oct. 15-17, 1912	524
23	Montreal, Que.,	Oct. 21-23, 1913	570
24	Los Angeles, Cal.,	Oct. 20-22, 1914	586
25	Detroit, Mich.,	Oct. 19-21, 1915	665
26	New Orleans, La.,	Oct. 17-19, 1916	710
27	Chicago, Ill.,	Oct. 16-18, 1917	704
28	Chicago, Ill.,	Oct. 15-17, 1918	716

	1895-6.	1896-7.	1897-8.	1898-9.
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	R. C. Sattley....	J. S. Lemond...	C .	C. W. Richey.
	H. Rettinghouse..	W. H. Finley..	H .	H. H. Eggleston
	J. S. Lemond....	C. W. Richey...	F .	B. J. Swett.

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	C. W. Richey	[illegible]	[illegible]	P. Swenson
	T. S. Leake	[illegible]	[illegible]	G. W. Rear
	W. H. Finley	[illegible]	[illegible]	W. O. Eggleston
	J. N. Penwell	[illegible]	[illegible]	W. F. Steffens

	1911-1912.	1912-1913.	1913-1914.	1914-1915.
President	P. [illegible]	[illegible]	[illegible]	L. D. Hadwen
1st. V.-Pres.	A. [illegible]	[illegible]	[illegible]	G. Aldrich
2nd. V.-Pres.	J. [illegible]	[illegible]	[illegible]	G. W. Rear
3rd. V.-Pres.	L. [illegible]	[illegible]	[illegible]	C. E. Smith
4th. V.-Pres.	T. [illegible]	[illegible]	[illegible]	E. B. Ashby
Secretary	C. [illegible]	[illegible]	[illegible]	C. A. Lichty
Treasurer	J. [illegible]	[illegible]	[illegible]	F. E. Weise
Executive Members	G. [illegible]	[illegible]	[illegible]	W. F. Steffens
	P. [illegible]	[illegible]	[illegible]	S. C. Tanner
	G. [illegible]	[illegible]	[illegible]	Lee Jutton
	W. [illegible]	[illegible]	[illegible]	W. F. Strouse
	E. [illegible]	[illegible]	[illegible]	C. R. Knowles
	W. [illegible]	[illegible]	[illegible]	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st. V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
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4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
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Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
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	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

CONSTITUTION *

ARTICLE I.

NAME.

SECTION 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

SECTION 1. The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussions, providing a medium for the exchange of ideas to the end that bridge and building practice may be systematized and improved.

SECTION 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The membership of this association shall be divided into two classes—active and life members.

SECTION 2. To be eligible for active membership, a person must be actively employed in railway service in responsible charge of the design, construction or maintenance of railway bridges, buildings or other structures; a professor of engineering in a college or university of recognized standing; an engineering editor, or a government or private timber expert

SECTION 3. To be eligible for life membership a person must have been a member of the association for at least five years and in general must have retired from active railway service. The association, however, may waive the latter condition by a majority vote of the members at a regular session for good and sufficient reasons. A life member shall have all the privileges of active membership and shall not be required to pay annual dues.

SECTION 4. Any member guilty of conduct unbecoming a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, may forfeit his membership on a two-thirds vote of the members present at any regular session of the association.

SECTION 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

* Revised October, 1914. Amended October, 1915.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary-treasurer and six executive members, all of whom shall constitute the executive committee.

SECTION 2. The past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECTION 3. Vacancies in any office for the unexpired term shall be filled by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial interests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECTION 2. Two-thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECTION 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association which convenes on the third Tuesday in October, and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

SECTION 2. The president, four vice-presidents and secretary-treasurer shall hold office for one year and the executive members for two years, three being elected each year. All officers will retain their offices until their successors are elected and installed.

SECTION 3. The term of office of the secretary-treasurer may be terminated at any time by a two-thirds vote of the executive committee. His compensation shall be fixed by a majority vote of the executive committee. The secretary-treasurer shall also serve as secretary of the executive committee.

SECTION 4. The secretary-treasurer shall be required to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

ANNUAL DUES.

SECTION 1. Every member upon joining the association shall pay to the secretary-treasurer three dollars membership fee and two dollars per year in advance for annual dues. No member one year in arrears for dues shall be entitled to vote at any election, and any member more than one year in arrears shall be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least sixty days previous to said regular meeting.

BY-LAWS*

TIME OF MEETING.

1. The regular meeting of this association shall convene annually on the third Tuesday in October at 10 a. m.

PLACE OF MEETING.

2. Places of holding the next annual convention may be proposed at any regular session of the association. All the places proposed shall be submitted to a ballot vote of the members present at the annual business session and the place receiving a majority of all votes cast shall be declared the location of the next annual meeting. If no place receives a majority of the votes cast, the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

3. It shall lie within the power of the executive committee to change the location of the meeting place if it becomes apparent that it is for the best interests of the association.

QUORUM.

4. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

DUTIES OF OFFICERS.

5. The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall

* Revised October, 1914. Amended October, 1915.

with the secretary-treasurer, sign all contracts or other written obligations of the association which have been approved by the executive committee. At the annual meetting the president shall present a report containing a statement of the general condition of the association.

6. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

7. It shall be the duty of the secretary-treasurer to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

NOMINATING COMMITTEE.

8. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, which shall prepare a list of names of nominees for officers to be voted on at the next annual convention, in accordance with Article VI of the constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE.

9. At the first session of each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary-treasurer and certify as to the correctness of his accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

COMMITTEE ON SUBJECTS FOR DISCUSSION.

10. After the annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEES ON INVESTIGATION.

11. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE.

12. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS.

13. 1st—Registration of members.
 2nd—Reading minutes of the last meeting.
 3rd—Admission of new members.
 4th—President's address.
 5th—Report of secretary-treasurer.
 6th—Payment of annual dues.
 7th—Appointment of special committees.
 8th—Reports of standing committees.
 9th—Unfinished business.
 10th—New business.
 11th—Election of officers and selection of place for holding next annual meeting.
 12th—Installation of officers.
 13th—Adjournment.

(Report of nominating committee to be read at first session of second day—Section 9 of By-Laws.)

DECISIONS.

14. The votes of a majority of the members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

15. All discussions shall be governed by Robert's rules of order.

DIRECTORY OF MEMBERS

Aagaard, P., Chief Inspector, I. C. R. R., Chicago.
Ailes, N. C., Asst. Val. Engr., D. & H. Co., Albany, N. Y.
Airmet, E. S., For. Ptr., O. S. L. R. R., Salt Lake City.
Alexander, S. Y., G. F. B. & B., St. L. B. & M. Ry., Kingsville, Tex.
Alexander, W. E., Supt. B. and B., B. & A. R. R., Houlton, Me.
Allard, E. E., For. B. & B., Mo. Pac. Ry., St. Louis.
Allen, T. H., Supv. B. & B., C. & O. Ry., Hinton, W. Va.
***Althof, L. W.**
Anderson, August, Gen'l For. B. and B., L. S. & I. Ry., Marquette, Mich.
Anderson, L. J., Supv. B. and B., C. & N. W. Ry., Escanaba, Mich.
Andrews, G. W., Asst. to Eng. M. of W., B. & O. R. R., Baltimore, Md.
Andrews, T. O., L. E. & W. R. R., Tipton, Ind.
Archbold, H. L., Div. Engr., Sou. Pac. Co., Tucson, Ariz.
Arey, R. J., 541 So. Cummings St., Los Angeles, Cal.
Ashby, E. B., Consulting Engr., L. V. R. R., New York City.
Ashmore, A. B., Supv. B. & B., M. L. & T. Co., Lafayette, La.
Ashton, D. H., Asst. Engr., O. S. L. R. R., Pocatello, Idaho.
Auge, E. J., Chief Carp., C. M. & St. P. Ry., Wells, Minn.
Austin, C. P., 107 Park St., Medford, Mass.

Bach, C. F., Supv. B. & B., C. & N. W. Ry., Belle Plaine, Iowa.
Bailey, F. W., Supt. M. of W., S. A. & A. P. Ry., Yoakum, Tex.
Bailey, S. D., 633 Hubbard Ave., Detroit, Mich.
Bainbridge, C. N., Engr. Design, C. M. & St. P. Ry., Chicago.
Ball, E. E., Div. Engr., A. T. & S. F. Ry., Fresno, Cal.
Ballard, C. F., Carp. For., S. A. L. Ry., Peachland, N. C.
Baluss, F. C., Engr. B. & B., D. M. & N. Ry., Duluth, Minn.
***Barber, N. N.**,
Barger, T. R., For. B. & B., L. & N. W. R. R., Homer, La.
Barnes, O. F., Div. Engr., Erie R. R., Jersey City, N. J.
Barrett, E. K., Supvr. B. and B., F. E. C. Ry., St. Augustine, Fla.
Barrett, J. E., Supt. of Track, B. and B., L. & H. R. Ry., Warwick, N. Y.
***Barry, E. J.**
Barton, M. M., 311 No. 34th St., Philadelphia, Pa.
Bates, Onward, Civil Engineer, McCormick Bldg., Chicago.
Batey, W. A., Supv. B. & B., U. P. R. R., Kansas City, Mo.
Beal, F. D., 800 Fife Bldg., San Francisco, Cal.
Beard, A. H., 705 No. 11th St., Reading, Pa.
Beeler, C. L., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
Beeson, R. W., Mast. Carp., C. & S. Ry., Trinidad, Colo.
Bender, Henry, Supv. B. & B., C. & N. W. Ry., Eagle Grove, Ia.
Bennett, D. E., For. B. & B., Mo. Pac. R. R., DeSoto, Mo.
Benz, F. A., Div. Engr., B. R. & P. Ry., E. Salamanca, N. Y.
Berry, J. S., Supt. B. and B., S. L. S. W. Ry., Tyler, Tex.
Bibb, J. M., Supvr. B. and B., L. & N. R. R., Birmingham, Ala.
Bigelow, F. M., Supv. B. & B., L. A. & S. L. R. R., Salt Lake City.
Bishop, McClellan, Mast. Carp., C. R. I. & P. Ry., El Reno, Okla
Bishop, R. R., For. B. and B., L. A. & S. L. R. R., Salt Lake City.
Black, G. W., Supt. McGrath Sand & Gravel Co., Pekin, Ill.
Black, J. D., Supvr. B. and B., P. M. R. R., Saginaw, Mich.

*In the National Service.

Blake, L. M., Supv. B. & B., B. & M. R. R., St. Johnsbury, Vt.
Blowers, S. H., For. Carp., B. & O. R. R., Columbus, O.
Bock, J. G., Gen. Br. Insp., C. St. P. M. & O. Ry., St. Paul, Minn.
Bohland, J. A., Br. Engr., G. N. Ry., St. Paul, Minn.
Bonner, J. K., Asst. Supvr. B. & B., N. Y. C. R. R., Rochester, N. Y.
Bourgeois, F. J., Supv. B. & B., N. O. G. N. R. R., Bogalusa, La.
Bouton, W. S., Engr. of Bridges, B. & O. R. R., Baltimore Md.
Bowers, Stanton, Bradford, O.
Bowers, S. C., Mast. Carp. of Brdgs., P. C. C. & St. L. Ry., Steubenville, O.
Bowman, R. M., Pur. Agt., Lackawanna Bridge Co., Buffalo, N. Y.
Boyd, G. E., Div. Engr., D. L. & W. R. R., Buffalo, N. Y.
Boyer, Grant, Div. For. B. & B., M. C. R. R., Detroit, Mich.
Brantner, Z. T., Supt. M. of W. Shops, B. & O. R. R., Martinsburg, W. Va.
Bratten, T. W., Supvr., B. and B., S. P. Co., Oakland Pier, Cal.
***Brewer, W. A.,** Asst. Engr., I. C. C., 914 Karpen Bldg., Chicago.
Bricker, H. R., Inspr. M. of W., B. & O. R. R., Baltimore, Md.
Briggs, B. A., 1075 LaFayette St., Denver, Colo.
Brookhart, N. D., Supv. B. & B., O. S. L. R. R., Pocatello, Idaho.
Brooks, G. E., Mast. Carp., C. R. I & P. Ry., Rock Island, Ill.
Brown, Alf., B. & B. Inspr., P. E. Ry., Los Angeles, Cal.
Brown, C. W., Sou. Pac. Co., Mina, Nevada.
Brown, E. H., Supv. B. & B., N. P. Ry., Minneapolis, Minn.
Brown, Thos., Br. Inspr., P. M. R. R., Saginaw, Mich.
Browne, J. B., Gen'l For. B. and B., K. C. C. & S. Ry., Clinton, Mo.
Browne, J. S., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
Bruce, R. J., Genl. Bldg. Inspr., Mo. Pac. Ry., St. Louis, Mo.
Buckley, J. E., Supvr. B. & B., B. & M. R. R., Fitchburg, Mass.
Bulger, Hugh, For. B. & B., Sou. Pac. Co., Oakland Pier, Cal.
Burckhalter, F. L., Asst. Gen. Mgr., Sou. Pac. Co., Los Angeles, Cal.
Burgess, W. H., Supvr. B. & B., Sou. Pac. Co., Stockton, Cal.
Burke, Daniel, Supvr. B. and B., Sou. Pac. Co., Tucson, Ariz.
Burnett, W. L., For. B. & B., St. L. I. M. & S. Ry., Eudora, Ark.
Burns, W. E., Asst. Eng., S. P. Co., San Francisco (care of G. W. Rear).
Burpee, Moses, Chief Engr., B. & A. R. R., Houlton, Maine.
Burrell, F. L., Supv. B. and B., C. & N. W. Ry., Fremont, Neb.
Busier, T. W., Plumb. For., B. & A. R. R., Pittsfield, Mass.
Byrd, J. E., Asst. For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Byrd, W. E., Asst. For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.

Caldwell, C. H., For. B. & B., Sou. Pac. Co., E. Bakersfield, Cal.
Caldwell, J. M., Insp. B. and B., C. I. & L. Ry., Lafayette, Ind.
Caldwell, J. T., For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Camp, W. M., Editor, Railway Review, Chicago, Ill.
Candee, Eldridge E., Sup B & B, N Y N H &HRR, New London, Conn.
Candee, Elliot E., Dist. Br. For., N Y N H & H R R, Waterbury, Conn.
Canty, J. P., Div. Engr., B. & M. R. R., No. Adams, Mass.
Cardwell, W. M., Mast. Carp., W. T. Co., Washington, D. C.
Carmichael, Wm., St. J. & G. I. R. R., Marysville, Kans.
Carpenter, J. T., 619 So. Gibson St., Princeton, Ind.
Cary, E. L., Richmond, Mo.
Case, F. M., For. W. S., C. & N. W. Ry., Belle Plaine, Ia.
Casey, W. W., For. B. & B., K. C. S. Ry., Texarkana, Texas.
Catchot, A. J., Supvr. B. & B., L. & N. R. R., Ocean Springs, Miss.
Cayley, W., Supvr., G. T. Ry., Stratford, Ont.
Clark, H. W., Supv. B. & B., Mo. Pac. R. R., Atchison, Kans.
Clark, J. H., M. of W. Clerk, Sou. Pac. Co., Tucson, Ariz.
Clark, W. A., Chief Engr., D. & I. R. R. R., Duluth, Minn.
Clopton, A. S., Supvr. B. & B., M. K. & T. Ry., Oklahoma City, Okla.
Clothier, E. E., Chief Carp., C. M. & St. P. Ry., Mobridge, So. Dak.
***Coffin, S. P.,** 1299 Commonwealth Ave., Allston, Mass.
Colclough, E., Gen. For. B. & B., A. T. & S. F. Ry., Fresno, Cal.

Cole, J. E., Gen'l Inspr., Sou. N. E. Ry., Providence, R. I.
Collings, Edwd., Chief Carp., C. M. & St. P. Ry., Perry, Iowa.
Conn, F. J., Supvr. B. & B., C. N. O. & T. P. Ry., Lexington, Ky.
Cooper, H. A., Roadmaster, T. I. Ry., Gananoque, Ont.
Copland, A. C., Office Engr., C. & O. Ry., Richmond, Va.
Copp, J. P., Roberts & Schaeffer Co., McCormick Bldg., Chicago.
Corbin, W. S., For. B. and B., Sou. Pac. Co., San Pedro, Cal.
Corey, S. T., Ch. Dftsman, Br. Dept., C. R. I. & P. Ry., Chicago.
Cota, G. M., Ch. Clerk, Eng. Dept., C. Vt. Ry., St. Albans, Vt.
Counts, D. E., Supv. B. & B., W. & A. R. R., Dalton, Ga.
Cowsert, L. A., Supv. W. S., C. N. O. & T. P. Ry., Danville, Ky.
Crawford, J. A., B. & B. Master, C. N. Ry., Saskatoon, Sask.
Creeks, J. L., For. B. & B., Sou. Pac. Co., Dunsmuir, Cal.
Crites, G. S., Div. Engr., B. & O. R. R., Baltimore, Md.
Cronin, Jno., Supv. B. & B., C. & N. W. Ry., Winona, Minn.
Crosman, D. M., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
Cullen, F. P., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Cullen, J. F., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Cummin, Joseph H., Brightwaters, N. Y.
Cunningham, A. O., Chief Engr., Wabash R. R., St. Louis, Mo.
Curry, Jno., For. B. & B., Mo. Pac. R. R., McGehee, Ark.
Curtin, William, Contractor, Govan, Saskatchewan.

Dale, Chas., For. W. S., I. C. R. R., New Orleans, La.
Dalstrom, O. F., Bridge Engr., C. & N. W. Ry., Chicago.
Danes, E. C., Gen. For., Wabash R. R., Peru, Ind.
Decker, H. H., Contractor, 2915 Ingersoll Ave., Des Moines, Ia.
Demars, E. A., G. F. Plumb. & W. S., O. S. L. R. R., Salt Lake City.
Derr, W. L., Supt., C. G. W. R. R., Clarion, Iowa.
de Ximeno, A., C. C. S. Corp., Obispo 59, altos, Havana, Cuba.
Dickerson, O. H., Prin. Asst. Engr., D. & I. R. R. R., Duluth, Minn.
Dickson, Geo., For. Brdgs., Sou. Pac. Co., Oakland, Cal.
Dickson, G. H., Asst. Engr., B. & B., T. & N. O., Ry., North Bay, Ont.
Dillabough, J. V., Asst. Dist. Engr., C. N. Ry., Edmonton, Alta.
Dittmar, F. C., Br. For., Sou. Pac. Co., Los Angeles, Cal.
Dodd, A. M., Supv. B. & B., C. of Ga. R. R., Macon, Ga.
Donaldson, C. E., Actg. G. F. B. & B., C. Vt. R. R., St. Albans, Vt.
Douglas, L. H., Mast. Carp., B. & O. R. R., Cleveland, O.
Drake, R. M., M. of W. Asst., Sou. Pac. Co., San Francisco, Cal.
Draper, F. O., Supt. of Bridges, I. C. R. R., Chicago.
Draper, I. A., Steel Erec. For., O. S. L. R. R., Pocatello, Idaho.
Drum, H. R., Chief Carp., C. M. & St. P. Ry., Mitchell, S. D.
Duckett, W. E., Asst. Engr., C. M. & St. P. Ry., Chamberlain, S. D.
Dufort, S. E., Supv. B. & B., B. & M. R. R., Concord, N. H.
Dupree, Jas., Supt. B. & B., C. T. H. & S. E. Ry., Chicago.
Durfee, T. H., Supv. B. and B., C. & N. W. Ry., Huron, S. D.

Easton, G. A., Gen. Scale Insp., Sou. Pac. Co., West Oakland, Cal.
Edwards, W. R., Sr. Struct. Engr., I. C. C., Washington, D. C.
Eggers, C. H., Mast. Carp., C. R. I. & P. Ry., Little Rock, Ark.
Eggleston, H. H., Supvr. B. & B., C. G. W. R. R., Des Moines, Ia.
Eggleston, W. O., Insp. of Bridges, Erie R. R., Huntington, Ind.
Elder, W. E., 720 So. 4th St., Burlington, Iowa.
Elliott, R. O., Supvr. B. and B., L. & N. R. R., Nashville, Tenn.
Elwell, H. A., Supvr. B. & B., C. G. W. Ry., Minneapolis, Minn.
Eskridge, F. A., Archt., C. & E., I. R. R., Chicago.
Esping, Chas., Mast. Carp., B. & O. C. T. R. R., Chicago.
Estes, C. F., For. Brdgs., Pac. Elec. Ry., Los Angeles, Cal.
Ettinger, C., Gen. Ptr. For., I. C. R. R., Chicago.
Eubanks, J. E., Br. For., S. A. L. Ry., Yulee, Fla.
Evans, J. J., Supvr. Signals, P. M. R. R., Saginaw, Mich.

Fair, E. W., Supvr. B. & B., B. R. & P. Ry., Du Bois, Pa.
Fake, C. H.
Farlow, R. F., Mast. Carp., B. & O. R. R., Tompkinsville, S. I., N. Y.
Faulkner, L. E., Ch. Engr., Miss. Cent. R. R., Hattiesburg, Miss.
Fellows, C. W., For. W. S., C. & S. Ry., Denver, Colo.
Fenwick, G. H., Gen. Br. For., M. C. R. R., St. Thomas, Ont.
Ferdina, A. H., For. B. & B., St. L. I. M. & S. Ry., St. Louis.
Ferris, B. F., For. B. and B., Sou. Pac. Co., Los Angeles.
Findley, A., 929 Wash. Ave., Portland, Me.
Fink, Albert, Gen. For. B. & B., D. L. & W. R. R., Buffalo, N. Y.
Finley, W. H., President, C. & N. W. Ry., Chicago.
Fisher, J. F., Bridge Inspr., Sou. Pac. Co., Sacramento, Cal.
Fisher, Morris, Supvr. B. & B., Sou. Pac. Co., Ogden, Utah.
***Fisk, C. H.,** Ch. Engr. Const., St. Louis, 5142 Westminster Pl., St. Louis.
***Fitzgerald, J. M.,** Roadmaster, C. of Ga. Ry., Macon, Ga.
Fletcher, J. W., Roadway Supt., Car. & N. W. Ry., Chester, S. C.
Fletcher, W. H., Room 21, Vauxhall Apt., Nashville, Tenn.
Flint, C. F., For. B. and B., C. V. R. R., St. Albans, Vt.
Flynn, M. J., Supv. B. and B., C. & N. W. Ry., Chicago.
Fraser, Alex., Supvr. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Fraser, James, Ch. Engr., N. S. W. Govt. Rys., Sydney, N. S. W.
Fraser, Neil, Supv. B. & B., Sou. Pac. Co., Dunsmuir, Cal.
Frazer, H. H., Div. For., Sou. Pac. Co., Dunsmuir, Cal.
Frazier, W. C., Supvr. B. and B., L. A. & S. L. Ry., Los Angeles.
Froese, Julius, Gen. For. B. & B., A. T. & S. F. Ry., LaJunta, Colo.
Fullerton, J. H., Supv. B. & B., B. & M. R. R., Woodsville, N. H.

Gable, Franklin, For. Carp., P. & R. Ry., Catawissa, Pa.
Gaby, F. A., Ch. Engr. P. C. of Ont., Toronto, Ont.
Gagnon, Ed., 408 Bryant Ave., North, Minneapolis, Minn.
Gardner, E. F., Mast. Carp., Erie R. R., Buffalo, N. Y.
Garner, R. D., Engr. Const., S. N. E. Ry., Providence, R. I.
Gaunt, Fred, Ptr. For., O. S. L. R. R., Pocatello, Idaho.
Gaut, J. B., Supt. B. & B., G. T. Ry., Detroit, Mich.
***Gauthier, A. I.,** Supvr. B. & B., B. & M. R. R., Concord, N. H.
Gehr, B. F., Mast. Carp., P. C. C. & St. L. Ry., Richmond, Ind.
Gentis, Ira, B. and B. Foreman, Sou. Pac. Co., Oakland, Cal.
George, W. J., Bay Road, Claremont, W. Australia.
Gerst, H. A., Asst. Br. Engr., G. N. Ry., St. Paul, Minn.
***Gilman, A. F.,** 1310 Hinman Ave., Evanston, Ill.
Giusto, Peter, For. B. & B., Sou. Pac. Co., San Francisco.
Glasgow, J. F., Gen For B & B, C St P M & O Ry, Worthington, Minn.
Gnadt, C. C., Br. For., Mo. Pac. R. R., Desoto, Mo.
Goldmark, Henry, Cons. Engr., 103 Park Ave., New York City.
Goldsmith, E. L., Supt. Const., L. I. R. R., Jamaica, N. Y.
Golson, W. P., Roadmaster, C. of Ga. Ry., Macon, Ga.
Gongoll, O. C., Asst. Supt. B. & B., Soo Line, Minneapolis, Minn.
Gooch, C. W., 1325 W. 9th St., Des Moines, Ia.
Gradt, Chas. Ch. Carp., C. M. & St. P. Ry., Savanna, Ill.
Graham, F. N., Asst. Engr., D. M. & N. Ry., Duluth, Minn.
Graham, Wm., C. E., 3027 Windsor Ave., Baltimore, Md.
Gratto, James, Supvr. B. & B., S. P. Co., Los Angeles, Cal.
Graves, Lon, For. B. & B., St. L. I. M. & S. Ry., Dermott, Ark.
Green, C. F., Supvr. B. and B., Sou. Pac. Co., Sacramento, Cal.
Green, E. H. R., Pres., Texas Midland R. R., Terrell, Tex.
Green, Z. A., Pilot, Fed. Val., G. C. & S. F. Ry., Galveston, Tex.
Greiner, J. E., Civil Engineer, 605 Continental Bldg., Baltimore, Md.
Griffith, F. M., Supvr. B. and B., C. & O. Ry., Covington, Ky.
Griffith, W. J., Mas. For., B. & A. R. R., Pittsfield, Mass.
Grover, J. H., Gen. For. W. S., A. T. & S. F. Ry., Needles, Cal.
Guild, Edward, Supv. B. & B., P. M. R. R., Grand Ledge, Mich.

Guire, W. A., For. B. & B., St. L. I. M. & S. Ry., Lake Providence, La.
***Guppy, B. W., Engr. Structures, B. & M. R. R., Boston, Mass.**

Haag, Orin, Carp. For., B. & O. R. R., Garrett, Ind.
Hadwen, L. D., Engr. Masy. Const., C. M. & St. P. Ry., Chicago, Ill.
Haley, W. S., Res. Engr., N. Y. C. R. R., Toledo, O.
Hall, N. L., Roadmaster, Sou. Ry., Winston-Salem, N. C.
Hall, Thomas, Asst. Supt. Bldgs., M. C. R. R., Jackson, Mich.
Hampton, H. A., Asst. Div. Engr., Sou. Pac. Co., Portland, Oregon.
Hancock, John, Asst. Engr., N. Y. C. R. R., Crown Bldg., Cleveland, O.
Hand, Geo. W., Valuation Engr., C. & N. W. Ry., Chicago.
Hanks, G. E., 814 No. Wash. Ave., Saginaw, Mich.
Hansen, Robt., Carp. For., Sou. Pac. Co., West Oakland, Cal.
Hansen, Rupert, 517 Redondo Ave., Salt Lake City, Utah.
Hargrove, J. C., For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Harlow, A. W., Mast. Carp., Erie R. R., Huntington, Ind.
Harman, H. H., Engr. of Brs., B. & L. E. R. R., Greenville, Pa.
Harman, Wm. C., Br. Inspr., Sou. Pac. Co., Bakersfield, Cal.
Harris, W. B., Supv. of Track, M. & O. R. R., Corinth, Miss.
Harrison, Chas., Gen. For., B. & B., M. V. Ry., Excelsior, Ark.
***Harshbarger, C. A.,** Asst. Br. For., O. S. L. Ry., Ontario, Ore.
Hartley, James, Supvr. B. and B., N. P. Ry., Staples, Minn.
Hartwell, J. R., Supv. B. & B., P. R. C. & N. W. Ry., Pierre, S. D.
Harvey, E. H., Foundation Shipbuilding Co., Portland, Ore.
Harvey, T. J., Bridge Insp., B. & A. R. R., Pittsfield, Mass.
Hausgen, W., Supvr. B. and B., M. P. Ry., Sedalia, Mo.
Hawk, A. T., Archt., C. R. I. & P. Ry., Chicago.
Hawkins, E. P., Genl. R. M., St. L. I. M. & S. Ry., McGehee, Ark.
Hayes, J. L., Div. Engr., C. R. I. & P. Ry., Rock Island, Ill.
Heiszenbuttel, H., Supv. B. & B., C. & N. W. Ry., Norfolk, Neb.
Henderson, J., Foreman B. and B., G. T. Ry., St. Thomas, Ont.
Henderson, R. C., Mast. Carp., C. H. & D. Ry., Dayton, O.
Herrig, C., For. W. S., C. & N. W. Ry., Wall Lake, Iowa.
Higgins, H. K., Cons. Engr., 209 McBride St., Jackson, Mich.
Hill, H. R., Asst. Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
Hillman, F. W., Div. Engr., C. & N. W. Ry., Madison, Wis.
Hinchee, J. M., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
Hitesman, U. S., Gen. For., N. Y. C. R. R., New York City.
Hodges, F. J., C. C., M. C. R. R., Jackson, Mich.
Hodges, H. P., Asst. Engr. W. S., N. C. & St. L. Ry., Nashville, Tenn.
Hofecker, Peter, Supvr. B. and B., L. V. R. R., Auburn, N. Y.
Hoffman, Geo. M., For. Ptr., P. & R. Ry., Shamokin, Pa.
Holcomb, J. W., Supvr. B. & B., L. V. R. R., Buffalo, N. Y.
Holdridge, H. D., Supvr. B. and B., Y. & M. V. R. R., Vicksburg, Miss.
Hopke, W. T., Mast. Carp., B. & O. R. R., Grafton, W. Va.
Horning, H. A., Supt. of Bldgs., M. C. R. R., Jackson, Mich.
Hotson, Wm. B., Supt. B. & B., E. J. & E. Ry., Joliet, Ill.
Howson, E. T., Eng. Editor, Railway Age Gazette, Chicago, Ill.
Hubbard, A. B., 32 Banks St., West Somerville, Mass.
Hudson, B. M., Supt. T. & B. V. Ry., Teague, Tex.
Hull, K. S., Genl. Supt., G. C. & S. F. Ry., Galveston, Tex.
Humbert, A. T., Mast. Carp., B. & O. R. R., New Castle Jct., Pa.
Hume, E. S., Deputy Com'r., W. A. Govt. Rys., Perth, W. Australia.
Hunciker, John, For. Bridge Erection, C. & N. W. Ry., Chicago.
Huntoon, J. S., Asst. Br. Engr., M. C. R. R., Detroit, Mich.
Hurst, Walter, Inspector, C. B. & Q. Ry., Chicago, Ill.
Hutchens, J. A., Bridge Insp., Sou. Pac. Co., Ogden, Utah.

Ingalls, F., Supvr. B. and B., N. P. Ry., Jamestown, N. D.
Ingram, Floyd, Supvr. B. and B., L. & N. R. R., Erin, Tenn.
Innes, J., Gen. For., G. T. Ry., Hamilton, Ont.

Irving, T. J., Asst. Engr., C. & N. W. Ry., Boone, Iowa.
Irwin, J. W., Supv. B. & B., C. & N. W. Ry., Chadron, Neb.
Isaacs, Jno. D., Consulting Engr., Sou. Pac. Co., New York City.

Jack, H. M., 519 W. Kolstad St., Palestine, Tex.
Jackson, E. A., For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Jackson, W. J., Div. Engr., C. & N. W. Ry., Winona, Minn.
James, A. J., Gen. For. B. & B., A. T. & S. F. Ry., Topeka, Kans.
James, Harry, Gen'l For. B. and B., C. & S. Ry., Denver, Col.
James, R. E., Supv. B. & B., L. V. R. R., Sayre, Pa.
James, Wm., Carp. For., Ill. Cent. R. R., New Orleans, La.
Jennings, Geo. H., Mgr. Powers-Thompson Const. Co., Joliet, Ill.
Jensen, C. A., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
Jewell, J. O., Supt. B. and B., C. T. H. & S. E. Ry., Terre Haute, Ind
Johnson, C. H., For. B. & B., P. M. R. R., Reese, Mich.
Johnson, Maro, Asst. Engr., I. C. R. R., Chicago.
Johnson, Nels, Supv. B. & B., C. G. W. R. R., St. Charles, Ill.
Johnson, Phelps, Pres. St. Lawrence Bridge Co., Montreal, Que.
Johnston, C. E., Genl. Mgr., K. C. Sou. Ry., Kansas City, Mo.
Johnston, J. H., Supt. B. & B., G. T. Ry., Montreal, Que.
***Jonah, F. G.**
Jonas, H. F., Engr. Struct., S. P. Lines, Tex. & La., Houston, Tex
Jones, L. E., Asst. Engr., N. O. & N. E. R. R., New Orleans, La.
Jones Pusey, Act. Engr. Strs., B & M. R. R., Boston, Mass.
Joslin, Judson, Genl. For. B. & B., L. V. R. R., Auburn, N. Y.
Jutton, Lee, Div. Engr., C. & N. W. Ry., Chicago, Ill.

Keefe, D. A., Consulting Engr., Athens, Pa.
Keith, H. C., Consulting Engineer, 13 Park Row, New York City.
Kelly, C. W., Peoples Gas Building, Chicago.
Kelly, J. A., Asst. Supv. B. & B., O. S. L. R. R., Pocatello, Idaho,
Kemp, A. E., For. B. & B., L. V. R. R., Hazleton, Pa.
Kendall, R., Mast. Carp., C. & W. I. R. R., Chicago. (83rd & Vine.)
***Kibbey, G. S.,** Asst. Engr., M. & St. L. R. R., Minneapolis, Minn.
Killam, A. E., 84 Highfield St., Moncton, N. B.
King, A. H., Supvr. B. and B., O. S. L. R. R., Pocatello, Idaho.
King. C. F., Div. Engr., C. & N. W. Ry., Omaha, Neb.
King, F. E., Dist. Carp., C. M. & St. P. Ry., Chicago.
King, T. H., Supv. B. & B., L. & N. R. R., Knoxville, Tenn.
Kinzie, H. H., Supvr. B. and B., N. Y. N. H. & H. R. R., Taunton, Mass
Klumpp, G. J., Supvr. Bridges, N. Y. C. R. R., Rochester, N. Y.
Knapp, F. A., Mast. Carp., Erie R. R., Jersey City, N. J.
***Knapp, G. A.,** Office Engr., G. C. & S. F. Ry., Galveston, Tex.
Knowles, C. R., Supt. Water Service, I. C. R. R., Chicago.
Krausch, W. T., Engr. Bldgs., C. B. & Q. R. R., Chicago, Ill.
Kulp, B. R., Trainmaster, C. & N. W. Ry., Antigo, Wis.
Kurokochi, S., Engineer, Imperial Govt. Rys., Tokyo, Japan.

Lacy, J. D., Insp., S. A. & A. P. Ry., 1410 Calhoun St., Houston, Tex.
Lacy, W. J., For. B. & B., St. L. I. M. & S. Ry., Poplar Bluff, Mo.
La Fountain, N. H., Asst. Supt. of B. and B., C. M. & St. P. Ry., Chicago
Land, G. W., Supvr. B. and B., St. L. I. M. & S. Ry., McGehee, Ark.
Large, H. M., Mast. Carp., G. R. & I. Ry., Fort Wayne, Ind.
Larsen, A.
Larson, John, Room 740, Transportation Bldg., Chicago.
Lattin, W. V., Supv. B. & B., N. Y. N. H. & H. R. R., Hartford, Conn
Lawrence, P. P., Asst. Supvr. B. & B., L. E. & W. R. R., Tipton, Ind.
Layfield, E. N., C. E., 61 Broadway, N. Y.
Leach, W. A., 179 Oak St., Holyoke, Mass.
Leake, T. S., Contractor, 6433 Kenwood Ave., Chicago.

Leavitt, F. J., Div. For. B. and B., B. & M. R. R., Sanbornville, N. H.
Lee, Frank, Engr. M. of W., C. P. R., Montreal, Que.
Lemond, J. S., Asst. to Ch. Engr. M. of W. & S., Sou. Ry., Charlotte, N. C.
Lentz, C. W., Genl. Bridge Insp., I. C. R. R., Memphis, Tenn.
Leonard, H. R., Engr. B. and B., P. R. R., Philadelphia, Pa.
Leslie, Andrew, Div. For., M. C. R. R., St. Thomas, Ont.
Lewis, E. R., Asst. to G. M., D. S. S. & A. Ry., Duluth, Minn.
Lichty, C. A., Gen'l Insp., C. & N. W. Ry., Chicago.
Little, C. A., Div. For. B. & B., B. & A. R. R., Concord, N. H.
Little, J. W., Asst. Supvr., B. & B., L. & N. R. R., Birmingham, Ala.
Littlefield, E. C., Ch. Clk., N. Y. N. H. & H. R. R., New Haven, Conn.
Lloyd, F. F., C. E., Petaluma, Cal.
Lodge, Harry, For. B. & B., Sou. Pac. Co., (care of G. W. Rear).
Loeffler, M., Supv. Brs., L. I. R. R., Jamaica, N. Y.
Loftin, E. L., Roadmaster, Q. & C. Ry., Vicksburg, Miss.
Long, M. A., Asst. to Ch. Engr., B. & O. R. R., Baltimore, Md.
Lorch, J. A., Asst. Engr., C. & N. W. Ry., Chicago.
Loughery, E., Gen'l For. B. & B., T. & P. Ry., Dallas, Tex.
Loughnane, George, Div. Engr., C. & N. W. Ry., Escanaba, Mich.
Loweth, C. F., Ch. Engr., C. M. & St. P. Ry., Chicago.
***Lutken, P. K.**, Gen. For. B. & B., N. O. M. & C. R. R., Laurel, Miss.
Lydston, W. A., 105 Norfolk Ave., Swampscott, Mass.
Lyman, C. R., For. Brgs., C. Vt. Ry., Waterbury, Vt.

Mace, B. S., Supt. of Insurance, B. & O. R. R., Baltimore, Md.
Mackenzie, W. B., Civil Engineer, Moncton, N. B.
Macy, E. C., Mgr. Trans. & Stores, Hog Island, Pa.
Manley, B. F., Gen. For. B. & B., Pac. Elec. Ry., Los Angeles, Cal.
Mann, J. M., G. F. B. & B., F. W. & D. C. Ry., Childress, Tex.
Manson, E. F., Mast. Carp., C. R. I. & P. Ry., Manly, Iowa.
Manthey, G. A., Supt. B. & B., D. S. S. & A. Ry., Duluth, Minn.
Marcy, C. A., Supv. B. and B., C. & N. W. Ry., Chicago.
Markley, A. S., Mast. Carp., C. & E. I. R. R., Danville, Ill.
Markley, J. H., Mast. B. and B., T. P. & W. Ry., Peoria, Ill.
Marsh, John, For. B. and B., B. & M. R. R., Lawrence, Mass.
Marsh, M. M., Supt. W. & B., Northern Ry., Squirres, Costa Rica, C. A.
Maruyama, Y., C. E., Sou. Manchuria Ry., Dairen, Japan.
Massenburg, W. G., Dist. Engr., G. C. & S. F. Ry., Galveston, Tex.
Mattos, F. D., Supt. Pres. Wks., S. P. Co., W. Oakland, Cal.
May, A. D., Asst. Engr., Mo. Pac. Ry., Little Rock, Ark.
May, Frank, For. B. & B., Mo. Pac. R. R., Charleston, Mo.
Mayer, M. J., Ch. Draftsman, Sou. Pac. Co., San Francisco, Cal.
McCabe, E. M., Supv. B. & B., B. & A. R. R., Pittsfield, Mass.
McCallum, A. D., For. W. S., C. H. & D. Ry., Hamilton, O.
McCandless, C. W., For. B. & B., Sou. Pac. Co., Ventura, Cal.
McCann, E., Gen. For. B. and B., A. T. & S. F. Ry., Wellington, Kans.
***McCaulley, S. W.**, C. E., 1428 E. 68th St., Chicago, Ill.
McClanahan, S. L., Div. Engr., C. R. I. & P. Ry., Herington, Kans.
McCloy, A. L., For. B. & B., P. M. R. R., Reese, Mich.
McClure, J. C. E., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
McCormick, R. S., Ch. Engr., A. C. & H. B. R., Sault Ste. Marie, Ont.
McCue, G. C., Gen. Supvr. B. & B., G. T. Ry., Ottawa, Ont.
McCully, C. S., Gen'l For. B. and B., N. P. Ry., Jamestown, N. D.
McDearmid, W. A., Mast. Carp., S. A. L. Ry., Charleston, S. C.
McDonald, Hunter, Ch. Engr., N. C. & St. L. Ry., Nashville, Tenn.
McFadden, T. E., Chief Carp., C. M. & St. P. Ry., Cedar Falls, Wash.
McGee, Danl., For. B. & B., Sou. Pac. Co., Sacramento, Cal.
McGonagle, W. A., Pres., D. M. & N. Ry., Duluth, Minn.
McGuire, Edwd., Ch. Carp., C. M. & St. P. Ry., Marion, Iowa.
McIlhenny, O. R., Office Engr., Chickasaw Shipbuilding Co., Mobile, Ala.
***McIntosh, Wm.**, Castle Stuart, Dalcross, Inverness-shire, Scotland.

McIver, B. T., R. F. D. No. 2, Box 367 B, Long Beach, Cal.
McKay, A. G., Div. For. Bldgs., N Y N H & H R R., New Haven, Conn.
McKee, D. L., Mast. Carp., P. & L. E. R. R., McKee's Rocks, Pa.
McKee, H. C., Supt. Bridges, C. of Ga. R. R., Savannah, Ga.
McKeel, W. S., Mast. Carp., G. R. & I. Ry., Grand Rapids, Mich.
McKibben, Robert, Mast. Carp., P. R. R., Altoona, Pa.
McLean, Neil, Bridge Inspector, Erie R. R., Huntington, Ind.
McLeod, Angus M., For. B. & B., Sou. Pac. Co., Oakland, Cal.
McMahon, Geo., For. B. & B., Sou. Pac. Co., Dunsmuir, Cal.
McMahon, Thos. D., Architect, G. N. Ry., St. Paul, Minn.
McNab, A., Supvr. B. and B., P. M. R. R., Holland, Mich.
*McNaughton, H. C.
McRae, D. A., Carp. For., C. P. R., Lethbridge, Alberta.
*McRostie, Roy, Asst. For. Const., O. S. L. R. R., Pocatello, Idaho.
McVay, A. B., Supvr. B. and B., L. & N. R. R., Evansville, Ind.
Mellgren, J., For. W. S., C. & N. W. Ry., Eagle Grove, Iowa.
Meyers, W. F., Supv. B. and B., C. & N. W. Ry., Boone, Iowa.
Miller, A. F., Mast. Carp., Penn. Lines W. of Pitts., Chicago.
Miller, C. E., Scale Insp., C. & N. W. Ry., Chicago.
Miller, J. W., Archt., C. & N. W. Ry., Chicago.
Miller, M. D., Spl. Engr., 740 Transportation Bldg., Chicago.
Mills, R. P., Supvr. Bldgs., N. Y. C. R. R., New York City.
Mitchell, G. A., Supt. B. and B., G. T. Ry., Toronto, Ont.
Mitchell, L. A., Eng. M. & W., U. T. Co. of Ind.; Anderson, Ind.
*Moen, J. D.
Montzheimer, A., Ch. Engr., E. J. & E. Ry., Joliet, Ill.
Moore, C. J., Mast. Carp., St. L. S. W. Ry., Pine Bluff, Ark.
Moore, E. G., For. Carpenter, B. & O. R. R., Flatwoods, W. Va.
Moore, W. H., Eng. of Brgs., N. Y. N. H. & H. R. R., New Haven, Conn
Moreau, C. L., Genl. For., B. & A. R. R., Springfield, Mass.
Morgan, Homer, For. B. & B., P. M. R. R., Greenville, Mich.
Morin, Theo., Br. For., B. & A. R. R., Pittsfield, Mass.
Morrison, E. C., Div. Engr., Sou. Pac. Co., San Francisco.
Mountain, G. A., Ch. Engr., Ry. Com. of Canada, Ottawa, Ont.
Mountfort, Albert, Div. For. B. and B., B. & M. R. R., Nashua, N. H.
Mulcahy, W. H., Supv. B. & B., C. & N. W. Ry., Adams, Wis.
Murphy, J. J., For. Water Service, Sou. Pac. Co., Oakland, Cal.
Murphy, R. E., For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Murray, J. R., Supvr. B. & B., A. G. S. R. R., Tuscaloosa, Ala.
Murray, Edwd., Asst. Engr. B. & B., C. M. & St. P. Ry., Miles City, Mont
Musgrave, C. T., For. B. & B., O. S. L. R. R., Idaho Falls, Idaho.
Musser, D. G., Mast. Carp., Penn. Lines W. of Pitts., Wellsville, Ohio

Nelson, M. E., Engr. Brdgs., A. C. L. R. R., Wilmington, N. C.
Nelson, O. T., Supt. M. of W., A. & W. P. R. R., Atlanta, Ga.
Nelson, P. N., Supv. B. & B., Sou. Pac. Co., San Francisco, Cal.
Newton, E. O., Div. For. Bldgs., N. Y. N. H. & H. R. R., Danbury, Conn.
Newton, R., Chester Shipbldg. Co., 101 W. 7th St., Chester, Pa.
Nies, A. B., Archt., M. C. R. R., Jackson, Mich.
Noland, W. B., Supvr. B. & B., O. A. & E. Ry., Sacramento, Cal.
Noon, W. M., 617 Ave. G., Miami, Fla.
Nuelle, J. H., Genl. Supt., N. Y. O. & W. R. R., Middletown, N. Y.
Nuss, G. K., G. F. B. & B., D. M. & N. Ry., Proctor, Minn.

O'Connell, Jno., Painter For., B. & A. R. R., Pittsfield, Mass.
O'Connor, W. F., Supvr. Bridges, L. I. R. R., Flushing, N. Y.
Oetzman, Emil, For. W. S., A. T. & S. F. Ry., Fresno, Cal.
Oldham, W. J., B. & B. Master, T. & N. O. Ry., North Bay, Ont.
O'Neill, P. J., Mast. Carp., N. Y. C. R. R., Adrian, Mich.
Osborn, F. C., Cons. Engr., 2848 Prospect Ave., S. E., Cleveland, O.
Owen, John, For. B. & B., D. & M. Ry., East Tawas, Mich.

Page, A. A., Div. For. B. & B., B. & M. R. R., Wilmington, Mass.
Palmer, E. F., For. B. & B., B. & M. R. R., Salem, Mass.
Parker, J. F., A. T. & S. F. Ry., San Bernardino, Cal.
Parker, W. V., B. & B. Fr., St. L. S. W. Ry., Box 358, Paragould, Ark.
Parks, J., 3347 Boulevard F., Denver, Colo.
Parsons, P. E., Asst. Supv. B. & B., O. S. L. R. R., Pocatello, Idaho.
Paterson, E. E.
Pauba, A. W., Mast. Carp., C. & S. Ry., Denver, Colo.
Paul, C. E., Prof. Mechanics, Armour Inst. Tech., Chicago.
Peabody, K., Asst. Supv. Bldgs., N. Y. C. R. R., New York City.
Penwell, J. N., Supt. Ogle Const, Co., Tipton, Ind.
Perkins, H. D., 1501 Walnut St., Danville, Ill.
Pettis, W. A., Gen. Supv. Bldgs., N. Y. C. R. R., Rochester, N. Y.
Phillips, B. P., Asst. Sup. B & B, N Y N H & H R R, Willimantic, Conn.
Pickering, B. F., Supvr. B. & B., B. & M. R. R., Salem, Mass.
***Pickering, F. M.**, Trainman, B. & M. R. R., Salem, Mass.
Pierce, Roy, Mast. Carp., Erie R. R., Salamanca, N. Y.
Pinson, J. F., Asst. Engr. B. & B., C. M. & St. P. Ry., Seattle, Wash.
***Piper, E. B.**, Div. For. B. & B., B. & M. R. R., Fitchburg, Mass.
Pitcher, C. G., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Plank, D. E. Supvr. B. and B., Pac. Elec. Ry., Los Angeles, Cal.
Pollard, Harry, Asst. Gen'l Br. Insp., S. P. Co., San Francisco, Cal.
Pollock, H. H., Mast. Carp. of Bldgs., P. C. C. & St. L. Ry., Carnegie, Pa.
Porter, Geo. F., Engr. Const., St. Lawrence Br. Co., Montreal, Que.
Porter, John W., Ch. Engr., Hudson Bay Ry., The Pas, Manitoba.
Porter, L. H., Box 35, Andover, Conn.
Post, J. C., B. & B. For., L. A. & S. L. R. R., Los Angeles, Cal.
Potter, A. K., Inspector, C. & N. W. Ry., Antigo, Wis.
Potts, J. O., M. of W. Inspr., B. & O. R. R., Baltimore, Md.
Powell, C. E., Genl. Insp. Brgs., C. & O. Ry., Hinton, W. Va.
Powers, G. F., Contractor (Newkirk & Powers), Joliet, Ill.
Purdy, G. A., Supv. B. & B., M. K. & T. Ry., Denison, Tex.

Quinn, William, Supt. B. & B., St. L. S. W. Ry., of T., Tyler, Tex.

Rankin, W. F., Mast. Carp., Pa. Lines West, Cambridge, Ohio.
Rask, A. G., Supt. B. & B., C. St. P. M. &. O. Ry., St. Paul, Minn.
Ratliff, W. L., Supvr. B. & B., I. C. R. R., McComb, Miss.
Ray, G. T., Supv. B. & B., St. J. & G. I. R. R., Marysville, Kans.
Rear, G. W., Gen'l Insp., S. P. Co., San Francisco, Cal.
Redfield, J. A. S., Div. Engr., C. & N. W. Ry., Fond du Lac, Wis.
Reed, Wm., M. of W. C., Mo. Pac. R. R., McGehee, Ark.
Rehmert, D. L., Mast. Carp., Pa. Lines W., Bradford, O.
Reid, R. H., Supvr. Bridges, N. Y. C. R. R., Cleveland, Ohio.
Replogle, J. S., For. B. & B., Sou. Pac. Co., Oakland, Cal.
Rettinghouse, H., Ch. Engr., C. St. P. M. & O. Ry., St. Paul, Minn.
Reynolds, A. W., Mast. Carp., P. R. R., Jersey City, N. J.
Reynolds, J. V., For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Reynolds, J. W., Carp. For., O. S. L. R. R., Pocatello, Idaho.
Rich, B. D., Painter For., Sou. Pac. Co., Stockton, Cal.
Richards, G. T., Supt. B. & B. Shops, C. M. & St. P. Ry., Tomah, Wis.
Richardson, R. W., Div. Engr., C. & N. W. Ry., Sioux City, Ia.
Ridgway, Arthur, Asst. Ch. Engr., D. & R. G. R. R., Denver, Colo.
Riney, M., Supv. B. and B., C. & N. W. Ry., Baraboo, Wis.
***Rintoul, D. T.**, Gen'l For. B. and B., Sou. Pac. Co., Bakersfield, Cal.
Roberts, A. C., Supv. B. & B., Mo. Pac. R. R., Monroe, La.
Robinson, A. W., Div. Engr., O. S. L. R. R., Pocatello, Idaho.
Robinson, J. S., Div. Engr., C. & N. W. Ry., Chicago.
Robinson, John, Supvr. B. and B., P. M. R. R., Grand Rapids, Mich.
Robinson, R. B., Engr. M. of W., O. S. L. R. R., Pocatello, Idaho.
Rodman, G. A., Supt. B. & B., N. Y. N. H. & H. R. R., New Haven, Conn.

Rogers, W. A., Civil Engineer, 37 W. Van Buren St., Chicago.
Rohbock, W. L., Ch. Engr., W. & L. E. R. R., Cleveland, Ohio.
Rohr, E. J., Asst. Br. Supv., C. & O., 2192 Shadwell St., Cincinnati.
Rose, Norman, Supvr. B. and B., Sou. Pac. Co., Portland, Ore.
Rose, W. M., For. Water Service, Sou. Pac. Co., Sacramento, Cal.
Ross, William, Chief Carp., C. M. & St. P. Ry., Millbank, S. D.
Rounseville, D., Asst. to Ch. Engr., C. & N. W. Ry., Chicago.
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Sampson, G. T., C. E., N. Y. N. H. & H. R. R., (retired), Medford, Mass.
Sattley, R. C., Valuation Engr., C. R. I. & P. Ry., Chicago.
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Sellew, W. H., Valuation Dept., M. C. R. R., Detroit, Mich.
Settle, T. H., Gen. For. B. & B., S. P. Co., Los Angeles, Cal.
Shane, A., Box 71, Indianapolis, Ind.
Shanklin, F. E., Gen. For., C. & N. W. Ry., Belle Plaine, Iowa.
Sharp. J. S., R. M., Sou. Ry., Hattiesburg, Miss.
Sharpe, D. W., 25 Wooster Place, New Haven, Conn.
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Travis, J. E., Pinehurst, Wash.
Tretheway, Thos., For. B. & B., Sou. Pac. Co., Stockton, Cal.
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Turner, W. F., Asst. Div. Engr., Sou. Pac. Co., Ogden, Utah.
Tyers, W. J., Supvr. B. & B., G. T. Ry., Belleville, Ont.

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Von Schrenk, Hermann, Cons. Timber Engr., 4276 Fladd Ave., St. Louis.

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Walker, I. O., Div. Engr., W. & A. R. R., Atlanta, Ga.
Wallenfelsz, J., Bridge Insp., P. R. R., 501 N. 6th St., Cambridge, Ohio.
Warcup, C. F., For. W. S., G. T. R., St. Thomas, Ont.
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Weise, F. E., Chief Clerk, Eng. Dept., C. M. & St. P. Ry., Chicago.
Welch, W. F., Asst. For., B. & A. R. R., Pittsfield, Mass.
Weldon, A., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
Welker, G. W., Supvr. B. and B., Southern Ry., Alexandria, Va.
Wells, C. R., Br. For., Sou. Pac. Co., Sacramento, Cal.
Wells, D. T., Genl. For. B. & B., O. S. L. R. R., Salt Lake City, Utah.
Wells, L. N., Div. For., B. & M. R. R., Woodsville, N. H.
Wenner, E. R., Supvr. B. and B., L. V. R. R., Ashley, Pa.
Wheaton, L. H., C. E., 26 So. Park St., Halifax, N. S.
Wherren, F. M., Div. For. B. & B., B. & M. R. R., Salem, Mass.
White, F. W., Supvr. B. & B., L. V. R. R., Sayre, Pa.
White, J. B., For. W. S., C. & N. W. Ry., Boone, Ia.
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Whitmee, G. Y., For. W. S., P. M. R. R., Grand Rapids, Mich.
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Wicks, Warren, Gen'l For., L. I. R. R., Amityville, N. Y.
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Wilkinson, W. H., Bridge Insp., Erie R. R., Elmira, N. Y.
Williams, J. C., Supvr., Georgia R. R., Decatur, Ga.
Williams, M. R., Gen. For. B. & B., A. T. & S. F. Ry., Las Vegas, N. M.
Wilson, E. E., Supv. Brgs., N Y C R R, New York City (81 E. 125th St).
Wilson, J., Supvr. B. & B., G. T. Ry., Hamilton, Ont.
Wilson, M. M. Div. Br. Inspr., Sou. Pac. Co., Los Angeles
Wilson, W. W., Div. Engr., G. C. & S. F. Ry., Cleburne, Tex.
Winter, A. E., C. E., 257 Cathedral Pl., St. Paul, Minn.
Winter, J. L., Mast. Carp., S. A. L. Ry., Waldo, Fla.
Wise, E. F., 207 Clay St., Waterloo, Iowa.
Wishart, J. J., Supvr. B. & B., N. Y. N. H. & H. R. R., Boston, Mass.

Witt, C. C., Dist. Engr., I. C. C., 1020 McGee St., Kansas City, Mo.
Wolf, A. A., Dist. Carp., C. M. & St. P. Ry., Milwaukee, Wis.
Womeldorf, C. F., Asst. Engr., C. & N. W. Ry., Chicago, Ill.
Wood, J. P., Supvr. B. & B., P. M. R. R., Saginaw, Mich.
Wood, J. W., Gen'l For. B. and B., A. T. & S. F. Ry., San Bernardino, Cal.
Wood, W. E., Dist. Engr., C. M. & St. P. Ry., Chicago.
Wright, C. W., Mast. Carp., L. I. R. R., Jamaica, N. Y.
Wright, G. A., Gen. For. B. & B., Ill. Trac. Sys., Decatur, Ill.

Yappen, Adolph, Asst. Engr., Br. Maint., C. M. & St. P. Ry., Chicago.
Yates, J. P., Gen. For. B. & B., N. O. T. & M. R. R., DeQuincy, La.
Yereance, W. B., Cons. Engr., 128 Broadway, New York City.
Young, R. C., Chief Engr., L. S. & I. Ry., Marquette, Mich.

Zenor, D., For. B. & B., L. & A. Ry., Stamps, Ark.
Zinsmeister, E. C., Mast. Carp., B. & O. R. R., Newark, O.
Zorn, J. F., For. B. & B., Pac. Elec. Ry., Los Angeles, Cal.

Total number of members 709.

Total No. of Members, Jan. 1, 1918,		709
Died,	11	
Resigned and dropped,	23	34
No. members Oct. 14, 1918,		675
New members Oct., 1918,		48
Total members Oct. 20, 1918,		723

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Austin, C. P., 107 Park St., Medford, Mass.
Bailey, S. D., Mich. Cent. R. R., Detroit, Mich.
Barton, M., 311 No. 34th St., Philadelphia, Pa.
Beard, Amos H., 705 No. 11th St., Reading, Pa.
Carmichael, Wm., St. J. & G. I. R. R., St. Joseph, Mo.
Carpenter, J. T., 619 So. Gibson St., Princeton, Ind.
Cummin, Jos. H., Bay Shore, N. Y.
Findley, A., 929 Wash. Ave., Portland, Me.
Gagnon, Ed., 408 Bryant Ave. North, Minneapolis, Minn.
Gooch, C. W., 1325 W. 9th St., Des Moines, Ia.
Green, E. H. R., Texas Midland R. R., Terrell, Tex.
Hanks, G. E., E. Saginaw, Mich.
Hubbard, A. B., 32 Banks St., West Somerville, Mass.
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Noon, W. M., Miami, Fla.
Parks, Jas., U. P. R. R., Denver, Colo.
Porter, L. H., Box 35, Andover, Conn.
Ross, Wm., C. M. & St. P. Ry., Millbank, So. Dak.
Shane, A., Box 71, Indianapolis, Ind.
Snow, J. P., 1120 Kimball Bldg., Boston, Mass.
Stannard, Jas., 1602 Broadway, Kansas City, Mo.
Tanner, Frank, Mo. Pac. Ry., St. Louis, Mo.
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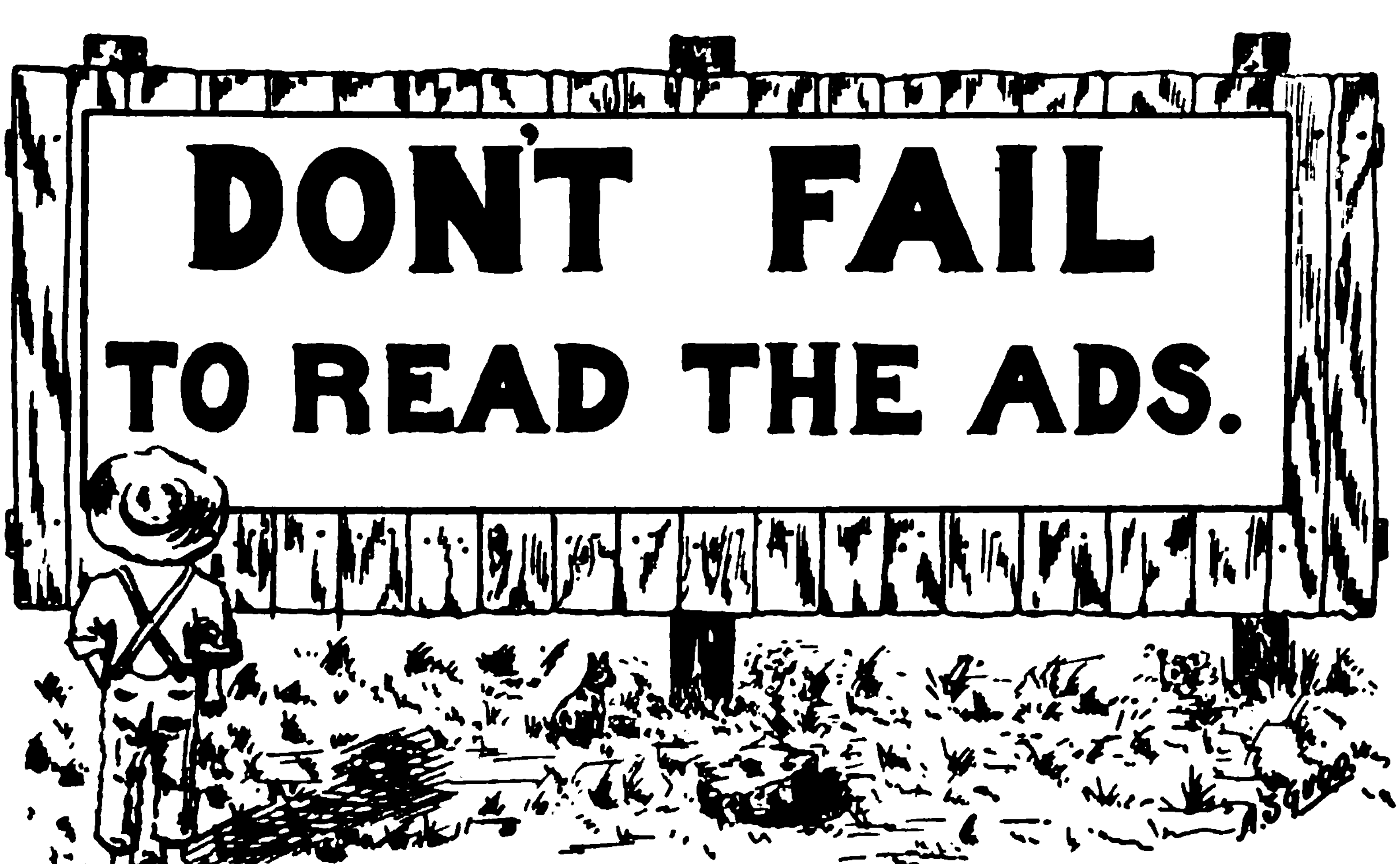

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Twenty-Ninth Annual Convention

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HELD AT

CLEVELAND, OHIO

October 21-23, 1919

REPORTS IN THIS ISSUE

Methods of Bridge Inspection
Inspection and Repairs of Roofs
Method and Equipment Used in Renewing Timber Bridges
Internal Combustion vs. Steam Engines for Pumping Water
Painting Metal Railway Structures
Pumping Fuels—Use and Storage
Fire Protection Equipment

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PROCEEDINGS OF THE

Twenty-Ninth Annual Convention

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HELD AT

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OCTOBER 21-23, 1919

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R. H. Helick, Mast. Carp., Penna., E. Liberty, Pa.
W. A. Clark, Chief Engr., D. & I. R., Duluth, Minn.

The Abuse of Treated Timber.

A. J. James, Gen. For. B. & B., Santa Fe, Topeka, Kans.
S. L. McClanahan, Div. Engr., C. R. I. & P., Herington, Kans.
J. S. Huntoon, Asst. Br. Engr., Mich. Cent., Detroit, Mich.
F. A. Taylor, Mast. Carp., B. & O., Cumberland, Md.
F. L. Thompson, Chief Engr., Ill. Cent., Chicago, Ill.
H. von Schrenk, Tim. Engr., 4276 Fladd Av., St. Louis, Mo.

Repair and Maintenance of Tank Hoops.

F. A. Benz, Div. Engr., B. R. & P., Salamanca, N. Y.
E. C. Zinsmeister, Mast. Carp., B. & O., Newark, O.
C. W. Wright, Mast. Carp., L. I., Jamaica, N. Y.
G. W. Welker, Supv. B. & B., Sou., Alexandria, Va.
J. H. Grover, Gen. For. W. S., Santa Fe, Needles, Calif.
A. W. Smith, Desig. Engr., C. N. Rys., Winnipeg, Man.
J. L. Winter, Mast. Carp., S. A. L., Waldo, Fla.

Application of Paint by Spraying.

James R. Shean, Ptr. For., P. E. Ry., Los Angeles, Calif.
A. W. Reynolds, Mast. Carp., P. R. R., Jersey City, N. J.
H. H. Harman, Engr. Brgs., B. & L. E., Greenville, Pa.
Chas. Ettinger, Gen. Ptr. For., Ill. Cent., Chicago, Ill.
O. F. Barnes, Div. Engr., Erie R. R., Jersey City, N. J.
J. S. Robinson, Div. Engr., C. & N. W., Chicago, Ill.
R. H. Reid, Supv. of Brgs., N. Y. C., Cleveland, O.

Maintenance of Timber Docks.

F. C. Baluss, Engr. B. & B., D. M. & N., Duluth, Minn.
R. C. Young, Chief Engr., L. S. & I., Marquette, Mich.
L. J. Anderson, Supv., B. &. B., C. & N. W., Escanaba, Mich.

W. J. O'Brien, Dist. Carp., C. M. & St. P., Milwaukee, Wis.
B. W. Guppy, Engr. Struct., B. & M., Boston, Mass.
H. A. Gerst, Asst. Br. Engr., G. N., St. Paul, Minn.
T. W. Bratten, Supv. B. & B., Sou. Pac. Co., Oakland Pier, Calif.
A. J. Catchot, Supv. B. & B., L. & N., Ocean Springs, Miss.
F. N. Graham, Asst. Engr., D. M. & N., Duluth, Minn.

Reclamation of Bridge, Building and Water Supply Materials.

G. T. Richards, Storekeeper, C. M. & St. P., Tomah, Wis.
P. Aagaard, Chief Insp., Ill. Cent., Chicago, Ill.
F. E. Schall, Bridge Engr., L. V., Bethlehem, Pa.
J. J. Murphy, For. W. S., Sou. Pac., Oakland, Calif.
W. A. Pettis, Gen. Supr. Bldgs., N. Y. C., Rochester, N. Y.
G. W. Andrews, M. of W. Dept., B. & O., Baltimore, Md.
J. J. Wishart, Supr. B. & B., N. Y. N. H. & H., Boston, Mass.
W. J. Jackson, Div. Engr., C. & N. W., Winona, Minn.

The Use of Electricity for Pumping Water.

L. A. Cowsert, Supr. W. S., C. N. O. & T. P., Danville, Ky.
E. A. Demars, G. F. W. S., O. S. L., Salt Lake City, Utah.
C. W. Fellows, For. W. S., C. & S., Denver, Colo.
E. R. Wenner, Supr. B. & B., L. V., Ashley, Pa.
A. I. Gauthier, Supr. B. & B., B. & M., Concord, N. H.
Geo. W. Rear, Gen. Insp., Sou. Pac. Co., San Francisco, Calif.

Maintenance and Repair of Freight House Floors.

F. H. Soothill, Bldg. Insp., Ill. Cent., Chicago, Ill.
D. Rounesville, Asst. to Chf. Engr., C. & N. W., Chicago, Ill.
J. P. Gallagher, Insp. Fire Protc., N. Y. C., New York, N. Y.
A. T. Hawk, Engr. of Bldgs., C. R. I. & P., Chicago, Ill.
C. P. Rawson, Archt., C. M. & St. P., Chicago, Ill.
T. D. McMahon, Archt., Grt. Nor., St. Paul, Minn.
C. J. Scribner, Bldg. Insp., C. B. & Q., Chicago, Ill.
D. L. McKee, Mast. Carp., P. & L. E., McKees Rocks, Pa.
S. C. Tanner, Mast. Carp., B. & O., Baltimore, Md.

COMMITTEES

Membership

H. A. Horning, Supt. of Bldgs., Mich. Cent., Jackson, Mich.
B. F. Gehr, Mast. Carp., P. C. C. & St. L., Richmond, Ind.
G. T. Richards, Storekeeper, C. M. & St. P., Tomah, Wis.
M. E. Nelson, Engr. Brgs., A. C. L., Wilmington, N. C.
L. A. Cowsert, Supv. W. S., C. N. O. & T. P., Danville, Ky.
A. M. Dodd, Supv. B. & B., C. of Ga., Macon, Ga.
T. H. King, Supv. B. & B., L. & N., Knoxville, Tenn.
J. L. Winter, Mast. Carp., S. A. L., Waldo, Fla.
D. E. Counts, Supv. B. & B., N. C. & St. L., Dalton, Ga.
J. B. Teaford, Supv. B. & B., Sou., Louisville, Ky.

Arrangements

O. T. Nelson, Engr. M. of W., Georgia, Atlanta, Ga.
H. McDonald, Chief Engr., N. C. & St. L., Nashville, Tenn.
W. A. Spell, Prin. Asst. Engr., Georgia, Atlanta, Ga.
E. K. Barrett, Supv. B. & B., F. E. C., St. Augustine, Fla.
I. O. Walker, Div. Engr., N. C. & St. L., Atlanta, Ga.
J. S. Lemond, Eng. Dept., Sou., Charlotte, N. C.

Nominations

A. Montzheimer, Chief Engr., E. J. & E., Joliet, Ill.
C. E. Smith, Cons. Engr., St. Louis, Mo.
Lee Jutton, Trainmaster, C. & N. W., Madison, Wis.
S. C. Tanner, Mast. Carp., B. & O., Baltimore, Md.
A. S. Markley, Mast. Carp., C. & E. I., Danville, Ill.

Subjects

C. R. Knowles, Supt. W. S., Ill. Cent., Chicago, Ill.
E. T. Howson, Ed. Ry. Mtce. Engr., Chicago, Ill.
A. T. Hawk, Engr., of Bldgs., C. R. I. & P., Chicago, Ill.
J. P. Wood, Supv. B. & B., P. M., Saginaw, Mich.

Publications

L. D. Hadwen, Engr. Masry. Const., C. M. & St. P., Chicago, Ill.
W. A. Rogers, Pres., Bates & Rogers Const. Co., Chicago, Ill.
Geo. W. Hand, Val. Engr., C. & N. W., Chicago, Ill.

Relief

R. C. Sattley, Val. Engr., C. R. I. & P., Chicago, Ill.
A. H. King, Supv. B. & B., O. S. L., Pocatello, Idaho.
G. W. Rear, Gen. Insp., Sou. Pac., San Francisco, Calif.
M. Riney, Supv. B. & B., C. &. N. W., Baraboo, Wis.

Obituary

G. W. Andrews, M. of W. Dept., B. & O., Baltimore, Md.
J. H. Cummin, Insp. of Heating, L. I., Jamaica, N. Y.

Proceedings of the Twenty-ninth Annual Convention
of the

American Railway Bridge and Building Association

Held at the Statler Hotel

Cleveland, Ohio, October 21-23, 1919

The twenty-ninth annual convention of the American Railway Bridge and Building Association was called to order in the convention hall of the Statler Hotel, Cleveland, Ohio, at 10:30 Tuesday morning, Oct. 21, 1919, by Lee Jutton, President, who called on J. H. Cummin to open the convention with prayer.

The President:—We are indeed fortunate to have present with us this morning the leading railroad man of Cleveland, a man who was once a member of the bridge and building department. He knows something of the problems with which we have to contend, and can sympathize with us. I refer to Mr. D. C. Moon, assistant to the federal manager of the New York Central Lines, who will make the opening address.

D. C. Moon:—Mr. President, Ladies and Gentlemen: I fail to see the Mayor of the city here to welcome you, and, therefore, as a fairly old citizen of this city I am going to take the liberty of offering a welcome to our city of Cleveland. I think that those of you who have never been here before will find it one of the most interesting cities that you have ever visited. We are all very proud of it.

When I was invited by your chairman of the entertainment committee he mentioned my saying a few words. I couldn't refuse an old Lake Shore man, so I consented. Afterwards I saw I was booked for an address, something that I really never gave in my life.

I feel much like the little boy who went to school for the first

time, at the age of six. The teacher promptly went around to him and asked his name, age, etc. Among other things she said, "Johnnie, do you know your A B C's?" and Johnnie replied, "Hell no, I have only been here five minutes. What do you expect?" (Laughter.)

In the presence of you technical and practical bridge and building experts, I feel the diffidence of a layman, and have found it difficult to think how I can best entertain you about the line of work for which you have a special training and a greater knowledge of the detail than I. However, I will try and give you a few ideas from my own life observations and trust they may be helpful to some of you at least.

My first experience on bridge work goes back to my age of about ten years, when my father took a contract, of some importance in those days, to build a two-bent highway bridge across a 20-ft. creek and in mud strata drove piling with a wooden hammer, weighing perhaps 200 lb., operated by horse power. I was the "handy jack" to haul back the hammer line, which, to me, was a most arduous and tiresome job. Since then, however, with over 40 years of railroad service, and a good part thereof in operating supervision, including maintenance and construction, I have taken great interest in that part of the work which the bridge and building engineers specially represent.

Railroad bridge building in its early progress from pile and frame and mud sill trestles and "bow-backs" to the more scientific "Howe Truss" with the tension rods put in unison by a "piano tuner" has afforded the greatest of opportunity for ingenuity and creative effort as shown by the great variety of spans and structures built, because whether for temporary and quick repair after a washout, fire, wreck, or other casualty, or to prepare for a fill, or to make a permanent structure, it must be made perfectly safe for a heavy moving load, and the width of the stream or water-way; the emergency flood; the ice gorge; flood wood; wash of banks and bed; the sweep and speed of current, and the tendency to undercut; the strata of soil, etc., all must be most seriously and carefully considered for a conclusion as to the location, form and quality of foundations for abutments and piers, regardless of the form of superstructure, and it requires the best of judgment to meet the practical requirements for safety and permanency with a good reasonable allowance for both, while at the same time not going so far as to be wasteful or

extravagant in cost with company funds, because bridge building at best is a very costly necessity in railroad construction and maintenance, and the earnings of a bridge costing, say $1,000 per lineal foot, is no greater than for the same length of track costing $5 per foot.

Each waterway, little or big, has its own peculiar characteristics and that applies to all from the six inch drain pipe to the biggest bridges ever built. Practical brainwork is especially needed in this, the preparatory stage of the job, and I do not hesitate to suggest to bridge engineers that they freely consult the old residents, the farmers, the millmen or the woodmen of the neighborhood about the characteristics of the stream; they have seen it at its worst and often can give historical and valuable information that may prove very useful, especially for new construction.

This foundation work is, of course, of the greatest interest, and has to be coupled up with nature's conditions and that of the structure you desire or may be required to build. Formulas and technical training are useful, but after all, of rather minor importance for this part of the work. Therefore, I urge all to be most painstaking and thorough in these elemental features. After these first points are fully determined, then naturally the more technical application of construction, coupled with good judgment, can be featured to the utmost.

How to construct the foundations and component parts to carry the structure that is to be built and that may be selected according to service necessities, is rather easily determined, after the elemental facts have been obtained as described. Will it be a modern type for one, two, three, four, or more tracks; how much head and span clearance is required; is it to be a through or deck girder, or concrete arch, or combination; is a draw or lift to be provided for? Usually these points are easily determined and then the technical part of the effort comes strongly into play, and the designing of the entire job, including the temporary support; the erection (especially if under traffic) of the type decided upon from among the great number of possibilities, requires the highest skill and education of the art along technical lines and from formulas worked out of experience. But, my friends, keep this ever bright before you,—that technical knowledge alone will never constitute success in railroad bridge building; couple it up with brains, apply deep practical thought and

practical judgment, and experience, and then it will accomplish everything.

My personal observations and experiences led me long ago to feel that as between the so-called practical "horse sense" and the technical or book knowledge separated, I would select for a majority of the jobs, the man with the former qualifications. You can buy books and technical knowledge, but you cannot buy brains. The purely technical man has usually proven a costly theorist, as many an employer has found out to his sorrow. But the practical man has moved along on safe lines, and been the employer's benefactor. Strive to be a combination man in every sense, and with that you surely will be a success.

Ten years as general manager of the Lake Shore Railroad, and many other years of experience and observation, lead to the conclusion that my remarks about bridge work are so applicable to buildings, and all other structures of railroad maintenance and construction, that special reference to the latter is unnecessary. Whether it be warehouse, stations, shops, coal docks, cinder pits, water tanks, or what not, the location, foundations and type of structure can be usually selected for material advantage of convenience and economy, and the practical good judgment, in this respect, here again, is foremost.

For closing, I will give you a few illustrating points, and I believe you will clearly get my idea:—

Many years ago a young engineer was in charge of some bridge construction on a new line in a hilly country and crossing the smaller or west branch of a stream, he built a 200-ft. span "Howe truss." Then about 20 miles below the confluence of the east and west branches, and crossing the main stream, where more than double the water flowed, he built another similar span 200 ft. long, that afterward proved to be ample; years later both required renewal and were replaced with steel, but years of observation led me to shorten the upper bridge to 100 ft., or half of original length, at considerable saving, and still later the original engineer riding over the road with me, confided as an old friend, that years ago, but after building the original structures, he had discovered that usually not as large bridges are required near the source as at the mouth of a stream, but he had kept his boyhood mistake to himself, letting others find it out for themselves. The promoters paid the bill for extra and use-

less cost, perhaps never knowing, but it was all there just the same.

Another instance,—An important double-track water way trestle burned out one very stormy night, and bridge builders, trackmen, material and machinery galore, were hurried to the broken point from both directions. In the meantime, the track supervisor, a most practical and competent man, with other "first aid" men, had arrived, rapidly cleared the debris, spiked planks to the piling near the water surface, laid other planks across for platform, and commenced to saw off the burned pile heads about six inches above lake level, to seat temporary bents to carry tracks. Time was everything, accuracy of saw line was nothing as differences could be adjusted during erection by shims. Yet, after the sawing was about half finished on this 400-ft. job, and every man working like Trojans, a young engineer arrived with a level, sent rodmen onto the platforms described, and the saw men just naturally stopped and made way for the engineer work, and it started to cause serious delay. Upon discovery, and the engineer asked why; he explained that he was going to make accurate marking for the saw men. Well, he naturally was quickly cleared away and work progressed. He had not quite sized up the job; he meant well, but his technique rather overbalanced his "horse sense." I am sure this experience opened his mind very wide, and later he was a very much more practical and efficient engineer.

One more illustration:— A few years ago the Lake Shore railroad built a new four-track lift bridge over the Calumet river at Chicago; it raises about 125 ft.; among other things of consequence, the lifting cables are quite an item of weight, for as you know, when the bridge is down they hang mostly inside the towers, whereas, when the bridge is lifting, their several tons of weight are transferred over the top pulleys to the outside, and the equi-balance of the bridge is or would be materially disturbed; and, whereby many high class engineers throughout the world have had more or less difficulty and worry from this source, and heavy lifts have been "passed up" for this reason, where otherwise desirable, and our chiefs and bridge engineers were also worrying me about their troubles during the planning. One day, Mr. Leffler solved the problem—he just hooked up the cable counter weights on the outside, to the pulley derricks, to take up or equalize as the bridge went up or down, and it worked

like a charm. Simple? Yes. But from my point of view, more real practical brain concentration was in that little one ideal thought than in all the rest of the job.

Study formulas and technique, for they must be used. But, don't forget to keep your mind working on the practical side of every job. (Applause.)

Chairman:—I will ask Mr. Cummin to make a few remarks in response to Mr. Moon.

J. H. Cummin:—Mr. President and Mr. Moon: I feel this morning somewhat like a cat in a strange garret. Some years ago I thought I was acquainted with every member of this association, but since I left the railroad business about 12 years ago, this association has outgrown my recollections; I have not been able to attend the meetings, and on being called upon by the president to address this assemblage I feel somewhat in the position of the old colored fellow going along the street in a dilapidated condition. The poor old fellow never had a dollar in the world. A gentleman came along and, meeting him, said, "Say, Uncle, please change a ten dollar bill for me, will you?" The old darkey looked up at him and said, "Golly, Massa, I'se sorry I can't do it, but I thanks you for the compliment." (Laughter.)

I would like to say to Mr. Moon that I have enjoyed his remarks a great deal, and I believe that if he will go through the membership of this association he will find that they are pretty close to one hundred per cent practical. They have a great deal of the theory. A large majority of them have attended colleges and secured the theoretical portion of it there, but since they have joined the different companies with which they are now connected they have gained the practical knowledge and they come together at these meetings to give us the benefit of that practical knowledge from year to year. I don't believe there is a member of this association that attends the sessions at these meetings but who goes home a great deal better qualified to fulfill the mission for which the company by which he is employed has engaged him. I thank you. (Applause.)

The President:—Ladies and Gentlemen, as your president it is necessary that I make a few remarks at the present time at the opening of this convention. It is certainly gratifying to see the large number present. I believe we are going to have a good convention. Indeed from the expression on your faces I know that we are going to have a good convention. This is the Twen-

ty-ninth convention of our association. Some here probably will recall the first meeting at St. Louis in 1891, at which there were 60 charter members, I believe, three of whom, I am glad to say, we have here today, J. H. and A. S. Markley and Mr. McNab. In addition I believe that 13 of the 60 charter members are still living. From this start of 60 we now have a membership of 730, and there are something like 80 new members to come in at this convention, so we will be close to 800.

That is very encouraging. It shows that as an association we are healthy and prosperous. The greatest thing that has caused us to be so is the fact that we always work in harmony. There has been practically no strife and dissension in the affairs of our association and we know that when that condition exists any association or any organization cannot help but go forward. I know that this association will continue so, and that our membership will increase greatly year after year.

During the past year death has taken ten members from us. One of these deaths was caused by a motor car accident. A few years ago we lost another member by a similar accident. Now we all know what the "Safety First" movement is. We know that it has reduced the number of deaths and injuries on the railroads to a very great extent.

I think that it would be well at this time to emphasize this safety movement somewhat. I believe that motor car accidents, in fact, all accidents, are more or less avoidable. We have many accidents that can be avoided, and I hope that every member of this organization will make a resolve that there will be no decrease in membership from now on due to motor car accidents or those of any other kind. This subject is especially fitting at this time, because we are now in the midst of the National Railroad Accident Prevention drive. I know that every one of our members will do all he can to come out one hundred per cent perfect so that it can be said that the Bridge and Building men did their part to eliminate accidents and to advance this accident prevention drive. The safety movement is a great thing, and it is worthy of every attention and effort we can give it.

This is the first convention of our association since the close of the war. We had something like thirty members serving in the Army of this country. We are proud of their record. They did their work and did it well. The war record of our association is something to be proud of. Every man did his part, knowing

that it was necessary to keep the railroads of this country in a high state of efficiency for the transportation of men and munitions. Knowing that, I believe that every one of us sacrificed a good deal of personal comfort in order to see that the work was properly done at all times.

Furthermore, we are a part of the greatest industry in this country. The railroads are vitally necessary to the welfare of the country, and being so, they must advance and improve. I know that the members of this association have kept abreast of the times. Nothing has been put up to them in the way of improved conditions or new methods of doing work that they have not mastered. They have met new conditions and have produced results—and good results. The last few years the conditions under which the railroads have had to operate have been severe, and we have been called upon to do things that we never thought we would have to do. You well know the trouble with labor, what we have had to contend with. The hours have been reduced and the amount of labor that we got for one hour has been considerably reduced. The price of materials has advanced to unthought-of figures. Under these conditions we have been asked to produce results, and I must say that the results have been forthcoming. We have had to give more time and attention to the details of the work, and under those conditions we have won out.

Last summer the secretary of our association and I visited Cleveland to confer with the committee on arrangements, and what we saw on that day convinced us that our association had made no mistake in choosing this city for its convention. You will find Cleveland filled with large industries, everything up-to-date, and will be well repaid for your trip here. I also wish to thank the committee on arrangements at this time for the work they have done. I know that they have worked long and hard in perfecting the arrangements for this convention, and I know that we all appreciate it. It is certainly fine to see the large number of ladies present. I hope our new members will appreciate this and see that their wives and daughters get the convention habit. This means, of course, that we have a large number of new ladies at every convention. They also need some attention. They should be made to feel welcome, and to be shown that we have a very happy convention family.

The committee reports for this convention are especially

good. A lot of work has been put on them, and I feel that we are going to get a great deal of good from them. The thanks of the association are due the men who have worked in making up these reports, but, as has been said before, their real reward is in the knowledge gained in working up the reports. It will be well for the other members to profit by their work, by studying these reports and entering into the discussions very fully.

In closing I want to say that I hope that the men will attend the business sessions, every one of them. Let us pay strict attention to business, for in so doing we will feel better when it is over, and enjoy more fully the pleasures that have been prepared for by the committee on arrangements. I thank you. (Applause.)

I will appoint F. E. Weise assistant secretary.

Before the ladies retire we will ask R. H. Reid, chairman of the committee on arrangements, to give us an outline of what has been arranged in the way of entertainment.

(Mr. Reid announces the various features of entertainment.)

The ladies may now retire.

If there is no objection we will dispense with the reading of the minutes of the last meeting, as they have been published and all have had an opportunity to read them. The reading of the minutes of the executive committee will also be dispensed with for the same reason.

Instead of a roll call we have adopted the card registration system. Our members are requested to register at the secretary's office just outside the convention hall.

(The registration showed the following members in attendance:)

P. Aagaard
C. J. Allen
L. J. Anderson
G. W. Andrews
F. C. Baluss
E. K. Barrett
J. M. Bibb
S. C. Bowers
G. Boyer
J. B. Browne
J. E. Buckley
F. L. Burrell
W. M. Camp
W. M. Cardwell
F. M. Case
A. J. Catchot
W. A. Clark
F. J. Conn
A. C. Copland
S. T. Corey
G. M. Cota
L. A. Cowsert
J. H. Cummin
W. L. Darden
E. A. Demars
C. E. Donaldson
J. Dupree
J. A. Dyer
F. A. Eskridge
C. Esping
C. Ettinger
R. F. Farlow
G. Fenwick
C. F. Flint
F. Gable
B. F. Gehr
Ira Gentis
O. C. Gongoll
C. Gradt
F. N. Graham
J. Gratto
F. M. Griffith
E. Guild
L. D. Hadwen
W. S. Haley
Thos. Hall
A. W. Harlow
W. C. Harman
A. T. Hawk
J. Henderson
R. C. Henderson
P. Hofecker
G. M. Hoffman
W. T. Hopke

H. A. Horning	C. J. Moore	C. U. Smith
W. B. Hotson	H. Morgan	E. W. Smith
E. T. Howson	C. T. Musgrave	R. W. Smith
J. Hunciker	D. G. Musser	F. H. Soothill
J. S. Huntoon	G. K. Nuss	L. Spalding
J. Innes	T. E. O'Brien	J. Spencer
A. J. James	P. J. O'Neill	G. H. Stewart
R. E. James	F. C. Osborn	E. G. Storck
J. O. Jewell	J. A. Owen	W. F. Strouse
M. Johnson	W. V. Parker	H. C. Swartz
Lee Jutton	J. Parks	W. G. Swartz
A. E. Kemp	W. A. Pettis	Wm. Sweeney
R. Kendall	R. Pierce	A. M. Swenson
A. H. King	J. F. Pinson	J. L. Talbott
F. A. Knapp	H. H. Pollock	S. C. Tanner
C. R. Knowles	G. W. Rear	D. B. Taylor
H. M. Large	D. L. Rehmert	F. A. Taylor
W. V. Lattin	R. H. Reid	J. J. Taylor
P. P. Lawrence	H. Rettinghouse	E. M. Tucker
J. S. Lemond	A. W. Reynolds	T. B. Turnbull
A. Leslie	G. T. Richards	W. J. Tyers
C. A. Lichty	A. Ridgway	O. E. Ullery
E. L. Loftin	M. Riney	C. G. Vollmer
W. Mahan	A. C. Roberts	C. F. Warcup
J. M. Mann	J. S. Robinson	P. N. Watson
G. A. Manthey	G. A. Rodman	F. E. Weise
A. S. Markley	W. A. Rogers	G. W. Welker
J. H. Markley	W. L. Rohbock	E. R. Wenner
W. H. Matthews	A. Ruge	J. B. White
E. M. McCabe	F. E. Schall	J. L. Winter
A. G. McKay	C. Scott	C. F. Womeldorf
W. S. McKeel	C. J. Scribner	J. W. Wood
A. McNab	A. C. Shields	C. W. Wright
W. F. Meyers	C. A. Sibley	R. C. Young
A. F. Miller	E. L. Sinclair	E. C. Zinsmeister

The following list of applicants, subsequently elected to membership, were also present:

L. B. Alexander	H. J. Groeninger	W. J. O'Brien
E. B. Brink	R. H. Helick	T. O'Hara
F. Burns	R. F. Henry	J. L. Pickles
M. M. Carmody	C. W. Heuss	C. P. Rawson
L. Clapper	B. J. Howay	H. W. Roberts
J. B. Clarke	E. H. Johnson	H. C. Shealy
M. M. Corrigan	T. P. Johnston	R. E. Sheehan
J. K. Davidson	W. E. Keir	J. P. Smallenberger
E. Drury	E. K. Lawrence	B. F. Stidfole
J. L. Enright	F. C. Loweth	O. C. Till
L. Firehammer	C. W. McFarland	J. H. Vosburgh
W. R. Gantz	F. H. Mitchell	H. B. Watters
J. M. Gibson		

Total number of members present, 196.

The President:—The next order of business is the election of new members. The membership committee, under the leadership of Mr. Horning, has been doing some good work, and it has a long list of applicants for membership. The secretary will

read the report of the committee together with the list of applications.

REPORT OF MEMBERSHIP COMMITTEE

The membership committee experienced an active season and is able to report a large number of applications from various parts of the country. The committee was materially assisted by many members and especially by the secretary.

Considerable difficulty was met in reaching many who were eligible but whose names did not show in the official lists. We call particular attention to this feature, for it is hoped that membership committees in the future may receive aid from all of the members in locating and going after such men, as it is important that we should extend an invitation to all who are eligible to become members.

The committee recommends for your consideration the following list of applicants for membership.

(Signed) The Committee.
By H. A. Horning, Chairman.

List of Applicants for Membership

Alexander, L. B., Asst. Br. Engr., M. C., Detroit, Mich.
Beck, L., Supt. B. & B., Virginian, Victoria, Va.
Bennett, W. J., Asst. Engr., G. N., Seattle, Wash.
Bracken, T. F., G. F. B. & B., C. St. P. M. & O., Emerson, Neb.
Brink, E. B., Supt. B. & B., L. E. & W., Tipton, Ind.
Bugg, C., Supv. W. S., G. T., London, Ont.
Buchholz, H. C., Ch. Carp., C. M. & St. P., St. Maries, Idaho.
Burns, Fred, G. F. Carp., C. N. O. & T. P., Somerset, Ky.
Carmody, M. M., Supv. B. & B., Sou., Big Stone Gap, Va.
Cavanaugh, Wm., Asst. Supv. B. & B., N. Y. C., Oswego, N. Y.
Chapin, F. H., Asst. Br. Engr., Alaskan Eng. Com., Anchorage, Alaska.
Clapper, L., Engr. B. & B., D. & I. R., Two Harbors, Minn.
Clarke, J. B., B. & O., Chillicothe, O.
Corrigan, M. M., Gen. Insp. Tunnels, B. & O., Cumberland, Md.
Crawford, I. C., Supv. B. & B., D. & R. G., Salt Lake City.
Crosby, P., Supv. B. & B., N. Y. N. H. & H., Danbury, Conn.
Davidson, J. K., Mast. Carp., Pa. Lines W., Jamestown, Pa.
Drury, Edwd., G. F. B. & B., A. T. & S. F., Newton, Kans.
Enright, J. L., Gen. Supv., B. & B., St. L. S. W., Tyler, Tex.
Estes, F. K., Asst. Supv. B. & B., U. P., Denver, Colo.
Everett, D. D., For. Plumb., Erie, Jersey City, N. J.
Firehammer, L. M., Supv. B. & B., Ill. Trac., Gillespie, Ill.
Gallagher, J. P., Insp. Fire. Protec., N. Y. C., New York, N. Y.
Gantz, W. R., Mast. Carp., P. R. R., Philadelphia, Pa.
Gault, A. K., Div. Engr., C. & N. W., Omaha, Neb.
Getman, Frank, Mast. Carp., Erie, Youngstown, Ohio.
Gibson, J. M., Supv. B. & B., G. T. R. in New Eng., Portland, Me.
Groeninger, H. J., Mast. Carp., P. R. R., Oil City, Pa.
Hamer, John, Supv. Bldg., N. Y. C., Albany, N. Y.
Hanson, J. A., Supv. B. & B., C. C. C. & St. L., Mt. Carmel, Ill.
Hawken, F. G., Insp. B. & B., D. S. S. & A., Marquette, Mich.
Helick, R. H., Mast. Carp., P. R. R., Pittsburgh, Pa.
Henry, R. F., Supv. B. & B., C. C. C. & St. L., Galion, Ohio.
Heuss, C. W., Supv. B. & B., C. C. C. & St. L., Indianapolis, Ind.
Howay, B. J., For. B. & B., P. M., Saginaw, Mich.
Hull, H. L., C. C., Eng. Dept., C. T. H. & S. E., Chicago, Ill.
Jackson, C. T., Dist. Engr., C. M. & St. P., Chicago, Ill.
Jamison, G. H., Ch. Carp., C. M. & St. P., Harlowtown, Mont.
Johnson, B. L., Genl. Mast. Carp., G. N., Spokane, Wash.
Johnson, E. H., For. Plumb., Erie, Elmira, N. Y.

Johnston, T. P., R. E., Sou. Pine Assn., New Orleans, La.
Keir, W. E., G. F. W. S., A. T. & S. F., San Bernardino, Calif.
Kemmerer, W. G., Asst. Mast. Carp., P. R. R., Erie, Pa.
Lawrence, E. K., Gen. Scale Insp., B. & O., Baltimore, Md.
Livingston, J. B., Supv. B. & B., St. L. S. W., Illmo, Mo.
Loweth, F. C., Asst. Trk. Elev. Engr., C. M. & St. P., Chicago, Ill.
Mansfield, A. G., Ofs. Engr., C. M. & St. P., Seattle, Wash.
McFarland, C. W., For. Carp., P. & R., Reading, Pa.
McHugh, W. H., Mast. Carp., P. R. R., Olean, N. Y.
Meier, G. A., For. B. & B., O. S. L., Brigham, Utah.
Miller, R. E., Brdg. Engr., St. L. S. F., St. Louis, Mo.
Mills, E. A., Gen. Mast. Carp., G. N., Crookston, Minn.
Mitchell, F. H., Mast. Carp., P. R. R., Ft. Wayne, Ind.
Musson, C. A. W., Asst. Engr., C. M. & St. P., Seattle, Wash.
Oaksmith, A., Supt. B. & B., Md. Elec. Rys., Annapolis, Md.
O.Brien, W. J., Dist. Carp., C. M. & St. P., Milwaukee, Wis.
O'Hara, T., B. & B. Mast., C. P. R., London, Ont.
Oppelt, H. H., Supv. B. & B., N. Y. C. & St. L., Conneaut, Ohio.
Perry, C. H., Div. Engr., C. & N. W., Antigo, Wis.
Pettis, C., Gen. Scale Insp., N. Y. C., Rochester, N. Y.
Pickles, J. L., Div. Engr., D. W. & P., West Duluth, Minn.
Rawson, C. P., Archt., C. M. & St. P., Chicago, Ill.
Rees, Edw., Br. Insp., L. I., Jamaica, N. Y.
Rivers, H. B., Ch. Carp., C. M. & St. P., Deer Lodge, Mont.
Roberts, H. W., Mast. Carp., P. R. R., Erie, Pa.
Scott, C. E., Eng. Brgs., M. C., Detroit, Mich.
Shealy, H. C., Mast. Carp., S. A. L., Hamlet, N. C.
Sheehan, R. E., Supv. Brdgs., C. B. & Q., Chicago, Ill.
Silcox, H., Mast. Carp., P. R. R., Jersey City, N. J.
Smallenberger, J. P., Mast. Carp., Erie, Meadville, Pa.
Stidfole, B. F., Mast. Carp., P. R. R., Bordentown, N. J.
Taylor, Geo., Asst., Engr., Sou. Pac., Dunsmuir, Calif.
Till, O. C., Mast. Carp., Belt Ry. of Chicago, Chicago, Ill.
Tuthill, G. C., Brdg. Engr., M. C., Detroit, Mich.
Vosburgh, J. H., Supv., B. & B., N. Y. C., Watertown, N. Y.
Watters, H. B., Ch. Engr., D. T. & I., Springfield, Ohio.
Weed, J. A., Supv. B. & B., O. S. L., Pocatello, Idaho.
Welch, F. J., Ch. Carp., C. M. & St. P., Tacoma, Wash.
Wier, J. M., Ch. Engr., K. C. S., Kansas City, Mo.
Wuerth, H., Asst. Engr., C. M. & St. P., Chicago.
Total number of applications, 80.

H. A. Horning:—I move that the secretary be authorized to cast a single ballot for the membership of the entire list. (Motion duly seconded and carried.)

G. W. Rear:—I move that the names of all applicants which are presented during the convention and receive the endorsement of the membership committee be placed on the roll as members.

The Chairman:—That I believe is customary, and unless there is objection we will see that that is done. We will now have the report of the secretary-treasurer.

REPORT OF THE SECRETARY-TREASURER

Since we met last year we have passed from wartime into the reconstruction period. On account of war conditions and the influenza epidemic, both of which were at their height when we met last, the at-

tendance at our last meeting was less than that at any convention since we met at Montreal in 1913. We are extremely fortunate in being able to state that we lost none of our members in army service and only one as a result of the influenza. This is truly a remarkable record when we recollect the conditions that confronted us a year ago. The outlook last year was the darkest in our history.

We have been called upon to chronicle the loss of 10 of our members by death during the past year. Wm. G. Hicks died Dec. 11, 1918; J. W. Little died Feb. 5, 1919; Chas. Dale died Feb. 9, 1919; J. J. Evans, date lacking; W. M. Noon died April 27, 1919; Wm. Spencer died June 1, 1919; John B. Sheldon died July 2, 1919; A. Mountfort died Sept. 26, 1919; W. E. Alexander died Oct. 5, 1919; Z. T. Brantner died Oct. 22, 1919. Memoirs of these members will appear in our proceedings.

Our membership has increased steadily during the past three or four years. Annual dues have been paid up more promptly and in greater proportion during the past year than for many years. Our finances are holding their own and it may truly be said that the Association is in a healthy and prosperous condition.

The financial report follows:

Chicago, Oct. 10, 1919.

Financial

Balance on hand at last report,		$1,043.79

Receipts

Dues and fees,	$1,300.00	
Advertising,	1,197.10	
Sale of badges,	15.50	
Sale of books,	24.85	
Interest,	39.25	
Total,		$2,576.70
Total on hand and received,		$3,620.49

Disbursements

Postage,	$ 108.05	
Printing and engraving,	1,065.31	
Stationery and office supplies,	14.85	
Editing,	70.00	
Stenographer,	80.20	
Expenses various committees,	30.00	
Badges,	37.50	
Salaries and office rent,	800.00	
Convention expenses,	55.30	
Telephone and telegraph,	11.85	
Miscellaneous,	21.65	
Total,		$2,294.71
Balance on hand Oct. 10, 1919,		$1,325.78

Of the above amount $500 has been invested in Liberty bonds bearing 4¼ per cent interest, and $300 in a first mortgage note at 6 per cent. The balance of $525.78 is on hand in the bank.

Respectfully submitted,

C. A. Lichty,
Sec.-Treas.

The President:—I will appoint a committee consisting of J. S. Robinson, F. E. Weise and R. C. Sattley to audit the books and accounts of the secretary-treasurer.

I will also appoint G. W. Andrews, S. C. Tanner and C. W. Wright a committee on resolutions. They will present their report at the close of the convention.

We will next hear the report of the committee on relief.

REPORT OF THE COMMITTEE ON RELIEF

Chicago, Oct. 18, 1919.

The committee on relief did not receive a call from any of our members asking for assistance in any manner, which indicates that none have been in want for employment.

The committee offers its assistance to those in need of positions at any time.

C. R. Knowles,
A. H. King,
G. W. Rear,
Committee.

The President:—We will now receive the report of the obituary committee.

REPORT OF THE OBITUARY COMMITTEE

Cleveland, Oct. 21, 1919.

To the Members of the Association:

Whereas, It hath pleased the Almighty Father of the Universe to call from our midst the following members: W. M. Noon, Wm. G. Hicks, J. W. Little, Chas. Dale, J. J. Evans, J. B. Sheldon, Wm. Spencer, A. Mountfort, W. E. Alexander and Z. T. Brantner,

Therefore, be it resolved, That the members present at this convention express their sorrow at the loss of these brothers by a rising vote, and,

Be it further resolved, That a copy of these resolutions be sent to the families of each of our departed members, and a page of our proceedings be set aside to the memory of each.

Respectfully submitted,

G. W. Andrews,
J. P. Wood
Committee.

The report was adopted and the members in convention arose in response to the resolution.

REPORT OF THE EXECUTIVE COMMITTEE

One meeting of the executive committee was held during the year.

Congress Hotel, Chicago, March 19, 1919.

Meeting called to order by President L. Jutton. Executive members present, L. Jutton, C. R. Knowles, J. H. Johnston, F. E. Weise, E. T. Howson, C. W. Wright and C. A. Lichty. Several past presidents and other members were also present.

R. H. Reid reported on the hotel situation at Cleveland, favoring the selection of the Statler hotel for convention headquarters. He also gave an outline of entertainment features decided on by the committee of arrangements. It was voted to leave the matter of arrangements and selection of hotel for headquarters to the committee together with the president and secretary.

No further business appearing the meeting was adjourned.

Statler Hotel, Oct. 20, 1919.

A meeting of the executive committee was held at the Statler Hotel on the eve of the convention which was called to order by first vice president, F. E. Weise, in the absence of the president.

Executive members present were F. E. Weise, E. T. Howson, C. W. Wright, C. R. Knowles, W. F. Strouse and C. A. Lichty. Past presidents present were G. W. Andrews, H. Rettinghouse, R. H. Reid, and J. H. Cummin.

R. H. Reid reported for the committee on arrangements stating what had been planned for entertainment, etc.

C. W. Wright made a motion to have a committee appointed to investigate our finances and report on the advisability of increasing the annual dues, and offering any necessary amendments to the Constitution, which motion was carried. The meeting then adjourned.

C. A. Lichty, Secretary.

Several letters and telegrams were read which had been received from members who found it impossible to be at the convention.

The President:—This completes the preliminary business. We will take up one of the subjects for report and discussion this forenoon. Mr. Ridgway desires to get away this evening and we will therefore take up the report of the committee on Methods of Bridge Inspection Under Present Conditions, of which he is chairman. (See report and discussion.)

Adjourned at 12:30 to re-convene at 2 o'clock.

AFTERNOON SESSION

Tuesday, Oct. 21, 1919.

The President:—We will continue the discussion on the report of the committee on Bridge Inspection.

When the discussion was concluded a letter was read from Col. Geo. H. Webb, chief engineer of the Michigan Central wherein he stated that it would be impossible for him to be present to take part in the program for Tuesday evening when he was to make an address on the work that he was connected with in France.

The second report taken up was that of Inspection and Repairs of Roofs. In the absence of the chairman the secretary read the report. (See report and discussion.)

The next subject taken up was that of Methods and Equip-

ment used in Renewing Timber Bridges which was read by the chairman, Maro Johnson. (See report and discussion.)

The meeting adjourned at 5 p. m. to reconvene at 9:30 a. m. Wednesday.

MORNING SESSION

Wednesday, Oct. 22, 1919.

The meeting was called to order by President Lee Jutton at 9:30 a. m.

The President:—We will hear the report of the nominating committee. The secretary will please read the report.

REPORT OF THE NOMINATING COMMITTEE

Cleveland, Nov. 22, 1919.

The committee on nominations recommends the advancement of the present officers and executive members one step as has been the custom (except the secretary-treasurer who is renominated), and that the name of G. A. Manthey be added to the executive committee to fill the vacancy caused by the promotion of the other members.

Respectfully submitted,

L. D. Hadwen,
S. C. Tanner,
A. Montzheimer,
Committee.

REPORT OF THE AUDITING COMMITTEE

Cleveland, Oct. 22, 1919.

The auditing committee has examined the books and accounts of the secretary-treasurer and has found them to be correct as given in the report.

J. S. Robinson,
F. E. Weise,
R. C. Sattley,
Committee.

The President:—The next in order of business is the presentation of a paper entitled Internal Combustion versus Steam Engines for Pumping Water, by C. A. Lichty.

(See paper and discussion.)

Following the discussion the report on Painting of Metal Railroad Structures was presented by C. T. Musgrave, the chairman. (See report and discussion.)

F. E. Weise:—A number of our members who were here Monday visited the plant of the Sherwin-Williams Co., and while there we invited Mr. George G. Mowat of that company to be present and take part in the discussion of this subject. Mr. Mowat has found it necessary to be out of the city today so he sent Mr. Swaney to read his paper.

(See paper and remarks by Mr. Swaney.)

The meeting adjourned at noon until 8:30 a. m. Thursday, to permit an inspection to be made of the Orange Ave. freight terminal and the Pennsylvania ore docks in the afternoon.

MORNING SESSION

Thursday, Oct. 23, 1919.

Meeting called to order at 8:30 a. m. by President Jutton.

C. R. Knowles read his paper on Railway Fire Protection Equipment. (See paper.)

Mr. Knowles also presented the committee report on the Economical Use and Storage of Fuel at Railway Pumping Stations. (See report.)

Discussion was first taken up on the latter subject, and later on Fire Protection Equipment. (See discussion.)

The President:—We will now proceed with the selection of the next place for holding the convention. Nominations are in order.

F. C. Baluss:—Our time is short, and I am not going to take a lot of time talking about this matter. I wish to place in nomination the city of Atlanta, Ga. It is well located geographically, and is a delightful place to hold a convention.

A. S. Markley:—I second the nomination. We held our 1901 convention there and we had a very fine time. The people turned out and gave us a barbecue and other amusements that were unique and interesting.

H. Rettinghouse:—Three years ago this convention voted to hold its next annual meeting in St. Paul. Owing to conditions over which we had no control, the place was changed to Chicago. At the time Mr. McGonagle and myself supported any move that was made to hold the convention in Chicago, doing away with entertainment features, etc. I know that many of the members would be very glad to please Mr. McGonagle. Owing to the great interest that he has always taken in the association and the great benefit that we have derived from this interest, I think that this association is morally obligated to vote for St. Paul for the next convention, and I place that city in nomination. We are at the point of returning to corporation control, and we can have our old fashioned conventions again. If you come to St. Paul I can assure you you will have just as nice a convention, just as good entertainment, as you had some years ago when you came to Minneapolis. In talking with Mr. McGonagle about it

I found that undoubtedly a trip could be arranged over the Iron Range. You have seen here the one end of the ore handling; you can see the other end there, both as to the production of ore and the loading, etc. We have also thought to give you a boat trip among the islands, at Ashland, Wis., one of the most beautiful spots on earth. If we can take the time, I can assure you that you will have a profitable side trip.

G. W. Rear:—I believe that Mr. Rettinghouse is right. This convention does owe an obligation to St. Paul. We voted for St. Paul almost unanimously, time and again, and then it did not get the convention. I believe we are duty bound to go to St. Paul and I second the nomination.

J. Dupree:—Mr. Chairman, I nominate Seattle, Washington.

C. R. Knowles: I simply want to add my bit to Mr. Rettinghouse's remarks about St. Paul. I think we are morally obligated to go there, and I want to express myself in favor of St. Paul.

R. H. Reid:—In seconding the nomination of St. Paul I concur in what Mr. Rettinghouse has said. We are under moral obligation to go to St. Paul, since we voted two years ago to go to St. Paul and certain preparations were made. Later the meeting was changed to Chicago, and St. Paul very gracefully acquiesced in the change. They conceded Chicago for a second time last year. We have been in the South two or three times since we were in the Northwest. We have been in the West and the East since we were in the Northwest. We have been in each principal section of the country since we were in the Northwest. I think it is only fair to Mr. McGonagle and the members from the Northwest that we hold a convention next year in their section.

The President:—We will vote on Atlanta and St. Paul, the other nominations not having been seconded.

A standing vote resulted in St. Paul receiving 56 and Atlanta 53 votes, to which A. S. Markley took exception and called for a ballot.

The ballot resulted as follows: Atlanta 82, St. Paul 66, whereupon the president declared that Atlanta would be the meeting place for the 1920 convention.

Chairman:—We will hear the report of the Committee on Subjects.

F. E. Weise:—The announcement was made from the platform inviting you to offer suggestions for subjects for the com-

ing year. Quite a number have responded. If you have any special subjects that you wish to have considered, you can present them in writing later on, and if the executive committee finds it desirable, it will work them in. Following is the list of subjects as recommended by the committee.

REPORT OF COMMITTEE ON SUBJECTS

Cleveland, Oct. 23, 1919.

The committee on subjects begs to submit the following list to be reported on at the next convention:

1. Filling Bridges (with special reference to the maintenance of structure during period of filling).
2. Standard Forms for Bridge Inspection.
3. The Abuse of Treated Timbers.
4. Repair and Maintenance of Tank Hoops.
5. Maintenance and Repair of Freight House Floors.
6. The Use of Electricity for Pumping Water.
7. Application of Paint by Spraying.
8. Maintenance of Timber Docks.
9. Reclamation of Bridge, Building and Water Service Materials.

The committee further recommends that the practice of presenting papers on special subjects be continued as has been the practice in recent years.

O. F. Dalstrom,
F. E. Weise,
E. T. Howson,
Committee.

It was moved the report of the committee on subjects be accepted. The motion carried.

R. H. Reid:—I would like to get in a word in connection with the report on subjects. I want to urge on all the members that, when the questionnaires come from the chairmen of these various committees, everyone respond, and give all the information you can. It is only by getting full information that we can get the best results. There are things that may seem common to us, individually, but they may be of great interest to some others who have not had particular experience along those lines. By getting complete information and advance discussion, sometimes in writing, we can make the association a complete success. That is what makes a live association and a live convention—good committee reports, good discussion, and where it is advisable, sound recommendation.

G. W. Rear:—I would like to add a word to that. In sending out the questionnaire it is very often true that it doesn't go to the right man. It goes to some man who is not particularly interested in the subject where it either becomes buried or is answered in a perfunctory manner. I would suggest that, in the

case of a railroad on which the chairman of the committee didn't know the right man to address, he send the questionnaire to some member of this association on that railroad. It would then, in all probability, get into the right hands. I have found numerous cases where the questionnaire didn't get into the right hands, and I have found many times where they have been answered that they have been answered by somebody just to get rid of them.

The President:—We will now have the report of the Committee on Resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS

Cleveland, Oct. 23, 1919.

Resolved:—That the thanks of the Association be extended to the following individuals and corporations:

To Mr. D. C. Moon, for his address of welcome and paper on bridge and building work, read in the convention:

To the United States Steel Corporation for furnishing moving picture films showing the methods of handling iron ore and coal at the docks, and the process of manufacturing steel:

To the New York Central officials for the instructive trip of inspection through the Orange Avenue freight terminal; and for furnishing a special train to convey our members from the Union Station to the Pennsylvania ore docks and return:

To the Pennsylvania Lines West, for their courtesy in assisting our party at its ore and coal docks and operating and explaining the machinery; and also for furnishing transportation and special cars for our party from Cleveland to Akron and return:

To the H. Black Company for its courtesy to the ladies on a trip through their plant:

To the Goodyear Tire and Rubber Co., for a trip of inspection through its plant at Akron:

To the Convention Board of the Cleveland Chamber of Commerce for its efforts and material assistance in making our convention a success:

To the management of the Statler Hotel for courtesies extended:

To the Pullman Company and the New York Central for special cars and rates to and from the convention:

To the officers of the United States Railroad Administration for their encouragement of our Association and its meeting this year, thereby contributing materially to our attendance and the success of the convention:

To the Bridge and Building Supply Men's Association for the exhibits and assistance in making the convention a success:

To the various members of the press in reporting and publishing the various activities of the convention:

To the officers, chairmen and members of the committees, for their time and efforts in carrying on the work of the Association:

Be it further resolved that these resolutions be spread on the minutes and the secretary be instructed to forward copies to all interested parties.

Respectfully submitted,

G. W. Andrews,
S. C. Tanner,
C. W. Wright,
Committee.

Chairman:—That brings us down to the election of officers. The report of the nominating committee, as you heard yesterday is: President, F. E. Weise; 1st Vice Pres., W. F. Strouse; 2nd Vice Pres., C. R. Knowles; 3rd Vice Pres., Arthur Ridgway; 4th Vice Pres., J. S. Robinson; Secy.-Treas., C. A. Lichty.

Members of Executive Committee: J. P. Wood, A. B. McVay, J. H. Johnston, E. T. Howson, C. W. Wright and G. A. Manthey.

G. W. Andrews: I move that the secretary cast a single ballot for the nominees.

(The motion of Mr. Andrews was carried unanimously by a rising vote.)

The Chairman:—Gentlemen, it gives me a great deal of pleasure to announce that our president for next year is Mr. F. E. Weise. Mr. Weise has been a good worker in this association, and the association is to be congratulated on having him for its president. Mr. Weise, I also want to congratulate you for being elected to the presidency of the association. There is nothing that I can say that will add to the able way in which I know that you will conduct the affairs of this association. I am very pleased indeed to present you with the gavel of authority. (Applause.)

Mr. Weise assumes the chair.

The Chairman:—Mr. Jutton and Gentlemen: I can hardly tell you how deeply I appreciate the honor which you have conferred on me by giving me the privilege of serving you this coming year. The association is being turned over to me in better shape than it has ever been before, and I can only repeat what has already been said, that the spirit of the members of the association has never been so evident as it has been at this meeting. Mr. Rear brought that out very forcibly in his talk last night. When this association was first founded nearly 30 years ago, the few people who gathered there did not realize how surely they were building. They met because they felt a need for getting together, exchanging their views and receiving the benefit of each other's experience. They brought their wives with them and they instituted something which has given this association a spirit of friendship and of mutual coöperation which very few associations have to such an extent. I hope that it will be carried on in the future. It is very evident at this meeting, and it has been growing from year to year.

I took occasion during the past year to look through some of the past proceedings of the association. It will do you all good to do that occasionally. You will find that each year the committees presented the very best that they had to give. Our proceedings constitute a record of the best practice for bridge and building men, and each year they have grown better. It is hoped that during the coming year we will be able to keep up the record that has been set. In looking over these proceedings I felt a deep sense of obligation. We are under obligation to those who have worked in the past, because they laid the foundation on which we have been building and thus assured the success of the association.

Personally I felt a deep sense of obligation, because this association has helped me more than I can tell you and in many ways. It has enlarged my acquaintance and enabled me to add to my list of friends many of the ablest railroad men in the country; a friendship that I value very highly. It has also been the means of adding very materially to my knowledge of many subjects that I would otherwise have passed over superficially through committee work and personal interviews with members from all parts of the country. I remember very distinctly the first time the secretary approached me and asked me to serve on a committee. I told him that I did not know anything about committee work and doubted if I could act on a committee. He said he knew better, but he did not tell me that he was going to make me chairman of the committee. I looked over the subject and concluded that it was an easy one. I thought I would not have to work very hard because there did not seem much to say. I thought that our road had the best practice on that particular subject, and all I would have to do would be to tell what we had. But I soon learned that other roads had different plans and methods and that the other members of the committee had ideas of their own. We got together, ironed out our differences, presented the report and, what is more, we formed a lasting friendship. I think that is the experience of most committee members.

I appreciate the privilege of serving you, and I know from the expressions that have been made that you will all do your part in keeping up the standard that has been set by those who have led the way. (Applause.)

C. W. Wright:—As we are on new business now I should like to suggest a life membership for Mr. Charles Wehlen, who

has been the bridge inspector of the Long Island Railroad for a long time, and who was retired on July 1 of this year.

G. W. Rear:—It has not been the practice of this association to give honorary membership to all men that are retired from active railroad service. I suggest that we confer life membership on all such.

The Secretary:—We have some charter members here who have paid dues in this association ever since it was organized. They have not asked to be placed on the honorary list or the list of life members, but they are as fully entitled to it as anyone else. The list of those who are actually retired from service is quite a long one, and although our constitution doesn't confine life membership to any certain number, I think it would be a good idea for the executive committee to take this list and determine how many of these men should be placed on our list for life membership. Some of these older members are worthy of it, perhaps all of them are, but I think this is a matter that we should consider very thoroughly before we act.

G. W. Rear:—I would just like to say that I don't consider that the conferring of life membership on anyone is going to be such an enormous obligation. It only reduces our revenues $2 per year for each member. If a man had only been in this association the length of time required by the Constitution, and has reached the age at which he receives a pension or has become retired, the conferring of life membership on him will not deplete the funds of the association to any great extent, while the man who has been a member of this association since its inception, and is still hale and hearty, and in active service, is under no great obligation in paying the regular dues. I urge that we ignore the dues and confer life membership on every man who is retired from his work on account of age.

The Secretary:—Section 3 of Article III in the Constitution reads as follows:

"To be eligible for life membership a person must have been a member of the Association for at least five years and in general must have retired from active railroad service. The association, however, may waive the latter condition by a majority vote of the members at a regular session for good and sufficient reasons. A life member shall have all of the privileges of active membership and shall not be required to pay annual dues."

We now have about 8 or 10 old members in the association who would like to be placed on the life membership list, and the

action that you take at this time will settle that matter. Unfortunately, I do not have the names of all of them with me.

J. H. Cummin:—I find myself in a peculiar position. Some years ago I resigned from the railroad with which I was connected, and at the next meeting of this association the members did me the honor to elect me a life member. I have gone back to the same road, and am now employed by that road, and I don't think it is any more than square that I should come in with my $2 per year. I don't consider that I am entitled to life membership in the association, inasmuch as I have gone back into active service.

P. J. O'Neill:—It always has been the general practice to put on the life membership list those who have been retired from active service. With the membership that we have today the question of the $2 does not enter into consideration nearly as much as it did 15 years ago. We don't miss the $2 now nearly as much as we did then, because our resources are so much greater. I would suggest that we give all retired members a life membership, or else that each individual be acted upon separately; not by the executive committee, but by the members.

G. W. Rear:—The only difference between the life member and the man who isn't the life member is that if a life member doesn't pay his dues, he is not dropped from membership. A man, after retiring, has probably little in the way of resources. He doesn't accumulate so much money, and when he becomes retired, about the first thing he will do is try to cut down the little expenses that he didn't think of when his pay check was coming in. Why should any man who has been in this association for 20 years, be dropped from membership when he becomes retired, on account of his unwillingness to incur the little expenses which he feels that he ought to cut out for the time being? I think we ought to vote for the bestowing of life membership on every man who has been a member for five years and becomes retired from service on account of age.

A. S. Markley:—I don't believe a man ought to be retired until he wants to be. When I am retired I want to know about it. I want you to have my consent before you do it. I am neither pensioned nor have we any old age list on our road. I expect to work there just as long as I can.

C. R. Knowles:—I don't know whether I am out of order, or not, but I would suggest that this matter be left to the execu-

tive committee, because I don't think we are going to get anywhere on the floor of the convention. I make that motion.

Chas. Ettinger:—Our Constitution provides that we can elect life members. Our membership has now reached a point where we can, I believe, fairly well afford it. One certainly will not refuse the honor that may be conferred on him, and it is an honor, conferred upon the old member, which he justly deserves, just the same as the pension is conferred on the man who has served in the ranks on the railroad. I believe that we should not do it for one. Don't take a few. Don't say to the executive committee later on, "You have done it for this man, but not for the others." Let the assembly act as a whole, right now, and confer the honor on one and all. (Applause.)

L. Jutton:—I move that we elect Mr. Charles Wehlen of the Long Island a life member. (Motion seconded and carried.)

G. W. Rear:—I move that we also confer life membership on every other retired man. (Seconded.)

L. Jutton:—It seems to me it would be a small matter for this association to consider every suggestion for life membership that comes up. I believe we ought to consider each one individually on its own merits.

G. W. Rear:—I would like to inquire on what basis each individual is going to be considered. Is it going to be on the recommendation of some person who comes in here with the interest of this other man at heart, or is it going to be put up by some man who is not represented here? It may be that a man out in some isolated quarter makes this recommendation, and he may be so far away, and so isolated, that we know very little about him. We lose the membership because that man has no one here to support him and make the motion that he be put on the life list. I request that a vote be taken on my motion.

E. T. Howson:—This question comes up each year. The discussion we have had this morning indicates there is a great deal of personal feeling and personal pride involved in this discussion. As a suggestion for a means of handling this, it would seem to me that it would be advisable for a letter to be sent to each member by the secretary, with other communications annually, before the convention, asking the members to suggest those who they think should be entitled to this honor; then that same officer of the association, either the executive committee or the secretary, communicate with those who are eligible

and who have been suggested to find out whether this action meets with their desire. After having that information, the name would be brought before the convention directly, or the executive committee itself could put the question before the convention. In that way we would not have recommendations made that are not in harmony with the member's wishes, and at the same time avoid any embarrassment. That will give the honor in any case where it is deserved.

L. Jutton:—I think Mr. Howson's suggestion is very good. As a matter of fact, I fear Mr. Rear's motion would mean a change in our Constitution.

E. L. Sinclair:—In seconding Mr. Rear's motion I thought we were in harmony with the provisions of the Constitution, which automatically conferred life membership on anyone who was retired. I thought the motion simply put that provision of the Constitution into effect.

W. M. Camp:—It happens that I find that some men are a little sensitive about being called "retired men." I have unwittingly run up against cases of that kind where a man had been retired from railroad service and didn't care to have it advertised, and I believe there are men in this association who would rather not have life membership forced upon them. I think this is a subject that ought to be laid over for a little while. Mr. Rear's motion would automatically make life members of all those who are retired up to the present time. As for those who might be retired during the coming year, there is no provision for them. Those who are retired from railroad service necessarily fall into that class. I think this matter ought to be laid over, and that the executive committee discuss the various phases of it, so that it can be taken up another year for consideration. Perhaps by that time it might be considered the proper thing to make life members of all men automatically, as soon as they retire from railroad service, but I think the information first ought to be ascertained whether that would be the desire of all men who are retired from railroad service. I actually believe there are some who would prefer to remain active members of this association.

P. J. O'Neill:—I consider it an honor to be placed on the honorary membership list of this association. I believe that all of the old members will consider that we have been honored by the association by being placed on the honorary list of life

members. A young man can't talk on this subject intelligently; he hasn't reached the age yet when it stares him in the face. I believe that I can talk for all of the old members, that they will feel it an honor that has been conferred upon them. They can attend the meetings and have all the rights and privileges they have always had. Where are you curtailing any of their rights and benefits?

R. H. Reid:—I move the question be laid on the table. Seconded by Mr. Knowles.

P. J. O'Neill:—If you find that motion is carried, that ends it.

R. H. Reid:—It is evident that this discussion would run on indefinitely. The motion to lay it on the table is not subject to debate. The question can be taken from the table later, after it has had further consideration by the membership.

P. J. O'Neill:—A motion laid on the table is killed forever, according to parliamentary procedure.

On rising vote the motion to lay on the table was carried.

The Chairman:—There is just one duty I want to perform before we come to adjournment. I would like to introduce to the new members the newly elected officers for this coming year. We will do that briefly by just asking them to stand in their places. (The new officers are introduced by the chairman.)

As our time is getting short, we will adjourn this meeting. I hope you will all boost for the convention at Atlanta.

Final adjournment at 11:00 a. m., Oct. 23, 1919.

C. A. Lichty, Secretary.

(Reported by LeRoy W. Hoskins on the Stenotype.)

CHARLES DALE

Charles Dale, supervisor of water service of the Illinois Central at New Orleans, was born at Gram, in the German Empire, January 9, 1871, and died at New Orleans February 9, 1919. He served in company E of the second regiment of United States volunteer engineers during the Spanish-American war and was honorably discharged from Camp Columbia, Cuba, April 14, 1899, his service record having been marked, "Excellent service, honest and faithful."

Charles Dale

At the close of the Spanish-American war Mr. Dale entered the employ of the Illinois Central railroad and served in that connection until his death, having been supervisor of water service during the last 12 years of his life.

Mr. Dale is survived by his widow. He was a prominent Mason, having been a member of several of the higher orders. He became a member of the Association at the time that the convention was held at New Orleans in October, 1916.

Z. T. BRANTNER

(By W. L. Stephens)

Zachariah Taylor Brantner, superintendent of the Baltimore & Ohio shops, at Martinsburg, W. Va., died at his home, 518 West Burke St., October 27, 1919, after a brief illness. Being possessed with a strong and rugged constitution and exerting the strong fighting qualities that had carried him so far along the road to success, he resisted the encroachments of disease and made a determined but losing fight against death.

Mr. Brantner was born near Martinsburg, W. Va., over 71 years ago and spent his boyhood days in and around this city. His early education consisted of such as could be obtained from the meager facilities existing in his home city at the time of his boyhood. Upon this small educational foundation, he, in after years, by close observance, careful study, and much reading builded a long and wonderful life of practical efficiency.

On January 1, 1863, at the age of 14 years he entered the employ of the Baltimore & Ohio Railroad as water boy in the maintenance of way department at Martinsburg, W. Va. Later he became a track hand. On February 1, 1864, he entered the machinery department as car oiler. On August 1, 1865, Mr. Brantner was made machinist apprentice under William Edwards, then master mechanic at this place, completing his apprenticeship in August, 1869. He was made gang foreman on locomotive overhauling in 1870. Continuing the upward trend he was promoted to foreman and transferred to the Valley Division in July 1874. After 12 years of conscientious service he was promoted to general foreman in December, 1886, and transferred to the Philadelphia Division. In May, 1891, Mr. Brantner was transferred to the Baltimore Division and placed in charge of the new shops in Brunswick, Md. On December 1, 1905, he was transferred to the maintenance of way department and placed in charge of the Martinsburg repair shops, thus returning to the place of

Z. T. Brantner

his entering the service of the railroad company, and to the same department in which he started his long railroad career. Upon returning to the maintenance department he immediately set about familiarizing himself with its requirements, and at the time of his death had acquired a thorough working knowledge of all maintenance necessities. The splendid record made by the shop under his supervision was largely due to his broad vision, keen foresight and exceptional executive ability.

On December 31, 1912, he was presented with a gold medal by the president of the Baltimore & Ohio Railroad in honor of his having attained a half century's service with the company. The presentation was made by A. W. Thompson, the vice-president. At the same time he was promoted to the position of superintendent of shops.

This year he had entered his 56th year of service with the Baltimore & Ohio, and during all these years he had never lost a day on account of sickness until October, 1890, when he suffered the loss of four fingers on his left hand while clearing a wreck on the Philadelphia Division.

Mr. Brantner was a thorough, efficient, and loyal railroad man. He knew the railroad game in all its branches and played it with a zest that never seemed to fail. In active service of the same company nearly 57 years is a record seldom equalled and tells its own story of competence and worth.

He had been a member of the relief department for nearly 40 years

and took great interest in its welfare. On his advice many employees purchased and now own their own homes. He organized the local lodge of the Veteran Employees' Association and had been its presiding officer since its inception.

In addition to his numerous railroad duties the deceased took particular part and delight in religious work and became a local preacher of much ability. All civic affairs, Y. M. C. A. work and fraternalism were subjects of the deepest interest to him. He became a member of the American Railway Bridge and Building Association in 1912, when the convention was held at Baltimore, and he took an active interest in its affairs.

WILLIAM SPENCER

William Spencer was born on October 3, 1845, in Lisbon, Kendall Co., Ill., and died at the National Sanitarium at Hot Springs, S. D., June 2, 1919, where he had gone a few days prior in search of treatment for heart trouble. He spent his boyhood days in the vicinity where he was born, receiving only a common school education. He took up farming in Kansas in an early day but lost all he had in the 70's during the grasshopper plague, and left the country on foot.

He entered the employ of the Chicago & Northwestern as a carpenter on the Galena division in 1885, and went to Chadron, Nebraska, in 1892, where he became superintendent of bridges and buildings of the Black Hills division of the Fremont, Elkhorn and Missouri Valley, now a part of the Northwestern Line. He held this position until he was pensioned in 1916, except two years, 1906-07, when he was engaged in the capacity of superintendent of construction on the Wyoming & Northwestern, a subsidiary line of the Northwestern, reaching from Casper to Lander, Wyo., a distance of 150 miles.

After being pensioned Mr. Spencer and his wife traveled extensively, the winter of 1916-1917 being spent in the vicinity of Miami where they were in constant touch with the Noons and "Deacon" Patterson. Mr. and Mrs. Spencer were on the Pacific coast during the war and while there he was engaged most of the time on ship construction at the Seattle and Portland shipyards.

Mr. Spencer was married to Marie Nolan, of Belvidere, at Chicago in 1888. He is survived by his widow, a brother, Thomas Spencer of Pueblo, a sister, Amelia Eccles of Tacoma, Wash., and a daughter, Mrs. Roy Bowers of Chadron. Interment took place at Greenwood cemetery at Chadron.

Mr. Spencer was a member of the Masonic fraternity and had been a member of the American Railway Bridge and Building Association since 1908, when the convention was held at Washington, D. C.

WILLIAM G. HICKS

William G. Hicks was born in Brooklyn, N. Y., June 8, 1879, and died Dec. 11, 1918 as a result of hardening of the arteries.

Mr. Hicks was in the employ of the Long Island Railroad for about 15 years, during which time he filled various positions in the maintenance of way department. At the time of his death he was in charge of labor distribution, and was also Liberty bond agent for the maintenance department.

He was married on June 23, 1898, to Martha Abrams of Rockville Centre. She was an invalid for about 14 years and preceded him in death about two years.

Mr. Hicks was active in civic and social affairs in Rockville Centre where he lived. He is survived by his father and mother (Mr. and Mrs. Charles N. Hicks), and his daughter, Vera G. Hicks. He joined the Association in 1916.

JOHN B. SHELDON

John B. Sheldon was born at South Kingston, R. I., on September 24, 1857, and died of heart trouble at his summer home at West Kingston on July 2, 1919. He had been in poor health for more than two years although he was able to carry on his work until the day before his death.

Mr. Sheldon entered the employ of the New York & New England railroad in the bridge department in 1881. After three years' service there he became bridge foreman on the New York, Providence & Boston, now a part of the New York, New Haven & Hartford. In 1901 he was appointed supervisor of bridges and buildings of the Providence division of the New Haven road with headquarters at Providence, and continued in that position until the time of his death.

Mr. Sheldon was married about 35 years ago to Nellie G. Brown of North Kingston. Their home for many years has been at Arlington,

John B. Sheldon

which is a suburb of Providence, but a part of the summers during the past 10 or 12 years were spent at West Kingston. Besides his wife he is survived by a brother, William S. Sheldon, who is employed by the New Haven road at India Point.

Funeral services were held at the Queen's River Baptist church, Usquepaugh, South Kingston, in the community where he spent the earlier years of his life; this church building having been designed and erected by Mr. Sheldon several years prior to his death.

Mr. Sheldon served as a member of the school board of the city of Cranston four years, and on the Arlington public library board. He was a member of the lodge of the United Order of the Golden Cross, in Woonsocket, and a member of the American Railway Bridge and Building Association, having served as president of the latter organization in 1906.

W. M. NOON

W. M. Noon was born in Merton, Wis., on June 28, 1846, and died at Miami, Fla., on April 27, 1919. When 21 years of age he was engaged as a subcontractor in cutting wood for fuel for locomotives on the Chicago, Milwaukee & St. Paul road. In 1868 he went to Iowa, where he was employed for several years in various capacities by contractors on railroad construction work, after which he took up construction work on his own account, his specialty being bridge building. One of his important projects for the Chicago, Milwaukee & St. Paul was the construction of a drawbridge across the Kinnickinnick river at Bay View in Milwaukee on the line between Milwaukee and Chicago. Mr. Noon continued work on this road for nearly 10 years, going with the Chicago & Northwestern in 1884, when, after two or three years, he went with the Fremont, Elkhorn & Missouri Valley. From this road he went with the Duluth, South Shore & Atlantic in 1889, where he occupied the position

William M. Noon

of superintendent of bridges and buildings until August, 1912, when he went to Jacksonville, Florida, where he was engaged for a time in concrete construction work. A year or two later, while in charge of the reconstruction of some railroad trestle in Florida, he sustained severe injuries in the collapse of a scaffold, upon which the carpenters were at work, from which accident he never fully recovered. Not being further able to prosecute work in the line in which he had been so actively engaged for so many years, he moved to Miami, Florida, in 1915, where, with the aid of Mrs. Noon, he conducted a small notion store on Avenue G, until the time of his death.

Although quite feeble, Mr. Noon was able to be about nearly every day. The evening prior to his death he was crossing the street near his store during a heavy rain when he was struck by a policeman's auto, which resulted in fatal injuries.

Mr. Noon was a prominent Mason and the funeral was in charge of Biscayne Bay lodge and Syrene commandery at Miami. He joined the American Railway Bridge and Building Association at the second annual convention held at Cincinnati in 1902.

W. E. ALEXANDER

(By Moses Burpee)

W. E. Alexander, superintendent of bridges and buildings of the Bangor and Aroostook, died at the Eastern Maine General Hospital, Sunday afternoon, Oct. 5, 1919, as the result of injuries sustained near Stockton Springs, Sept. 30, when the motorpede he was riding was derailed.

Mr. Alexander was born at Fredericton Jct., N. B., Dec. 17, 1848. He was married to Jennie Taylor, of Grand Falls, N. B., who died Jan. 25, 1913. Two sons survive, Burpee, who served as lieutenant in the Canadian Pioneers in France, now of Bear River, N. S., and Lieutenant William H. Alexander in the Naval aviation service attached to the U. S. S. Shawmut, now at Philadelphia.

W. E. Alexander

In earlier years Mr. Alexander was for some time with the Chicago, Milwaukee & St. Paul, and several years with the United States government, engaged in building dams on the upper Mississippi. Later he returned to New Brunswick to take charge of bridge work on the New Brunswick Railroad, and when the road was leased by the Canadian Pacific he remained with the latter company for several years. In the winter of 1893-94 he went to Maine, where he was engaged with the contractors in erecting steel and temporary wooden bridges for the Bangor & Aroostook until the railroad was completed to Caribou in 1895. For a short time he was employed by the late Thomas H. Phair in starch factory repairs.

In 1897 Mr. Alexander entered the employ of the Bangor & Aroostook and located at Houlton, Maine, where he became an American citizen. He was a deacon of the Houlton Free Baptist church, a constant attendant and untiring worker in support of its services. He belonged to Monument Lodge F. & A. M. of Houlton, and had been a member of the American Railway Bridge and Building Association since 1901.

METHODS OF BRIDGE INSPECTION UNDER PRESENT CONDITIONS

Report of Committee

The report of the committee on Subjects was dated October 15, 1918, and included among others the subject herein treated. It seems quite likely to the members of this committee that the subject assigned was suggested by the then present conditions which involved perhaps different treatment while the nation was in a state of warfare than conditions which now prevail in the readjustment period following the signing of the armistice on November 11, 1918. Conditions are even now considerably different than at the time of the assignment of the subject to the committee, and they are constantly changing day by day. It is therefore difficult to make an analysis with any degree of assurance that the report will be representative.

There are, generally speaking, two kinds of inspection of bridges, one for the detection of defects involving immediate safety, and the other for the detection of waning serviceability. We assume that since the first is primarily a matter of constant patrol of the railway lines, the second is to be the subject of our investigation. What is herein contained pertains exclusively to the matter of inspection as involved in current maintenance from year to year.

To prepare any information of value to the members of the Association, it was necessary to canvass the situation thoroughly with regard to the different methods of inspection in vogue throughout the country. Accordingly, a questionnaire was circulated under date of February 23, 1918, a copy of which appears in Appendix "A." To this questionnaire only 40 replies were received, involving about 90,000 miles of road, although it was sent to 100 different railroads.

The illusive character of the subject rendered it imperative to secure as much detailed information as could consistently be requested, which necessity in turn required a rather involved set of questions. The wide expanse of the country traversed by our railways suggested the thought that perhaps the methods of bridge inspection might be influenced somewhat by climatic or meteorological conditions, and therefore carriers were asked, in replying to the questions, to name the mileage by the states to which the replies were applicable. This would enable the committee to determine readily whether or not the geographical position of the lines reflected any definite influence in the method of inspection in use.

It was surmised at the outset that inspections were conducted by persons of various official rank and title, and accordingly it seemed necessary to ask for information as to this particular phase of the matter.

Another very important detail in the matter of bridge inspection is the method by which the inspector traverses the property; hence the inquiry as to the means of locomotion for the inspection party.

There are various tools and kinds of equipment which can be used to facilitate the actual work of the inspection, and an inquiry was made as to this phase of the matter in an effort to assemble data pertinent to the kinds most generally in use.

One of the most important features in connection with a bridge inspection is the means which the inspector uses for recording the results of the examination. Therefore an endeavor was made to assemble all the available forms which are customarily used for the purpose. An

effort was also made to secure information as to the minuteness of the inspection as well as to determine the precise methods used in prosecuting the actual details of the work.

Then there naturally follows an inquiry into the disposition of the findings of the inspector. This of course involves a determination of the matter of handling the inspector's notes, when and how his recommendations are carried out and the governing factors which are made the basis of his recommendations.

Finally the committee was desirous of receiving any suggestions as to the whole matter of bridge inspection as viewed by the officers reporting for their respective lines.

Replies to this questionnaire immediately indicated that not only the methods in general, but the disposition of the inspector's notes and compliance with his recommendations were widely different for the two classes of bridge structures, metal and wood. It is therefore proper for us to report our findings separately for these two general classes of bridges, based upon the assumption that the classification of wooden bridges is constituted by wooden trestles and that the inspection of wooden truss bridges requires treatment very similar to that of metal truss spans.

Metal Bridges

While climatic conditions do have a very material effect on the durability of metal bridges, yet from the replies received, no general statement can be made that territorial location is responsible in any way for the methods used in inspection. It is unfortunate that the replies received by the committee do not state definitely that the frequency of inspection of metal bridges differs from that of wooden structures. This was probably due to an oversight of the committee in not asking specifically for information as to the frequency of metal bridge inspection in distinction from that of wooden bridges. It can, however, be stated generally that an annual inspection of metal structures is more generally in effect than that of any other periodicity. It may also be stated that the officer conducting the inspection of metal bridges is more frequently chosen directly from the staff of the chief engineer than from any other group of officers.

The motor car seems to be decidedly the most common means of locomotion for the inspection party.

As reported to the committee, the inspection tools for metal bridges consist generally of rivet hammers, calipers, rules and tape measures.

By far the greater number of railways and the greater portion of the mileage represented in the replies to the committee report the use of regular forms for taking and recording notes in the field. These forms are so diversified in character and extent that their presentation to the Association as a body is not possible. It may suffice to say that they range from ordinary mimeograph forms to bound note books. Some require notes to be taken in detail, others contemplate the record being made in narrative form. Many of them seem to cover the matter very comprehensively, while others are painfully lacking in provision for making the requisite notes adequately.

In the absence of regular forms for the purpose, the manner of making the notes is about as diversified as were the replies from those railroads which have no forms.

With metal bridges, as is to be expected, by far the greater number of railways operating make inspection separately for the various members.

As to whether actual measurements are taken to determine the amount of deterioration or decay, or whether such determination is based on general appearances in judgment, the replies received were unfortunately not specific as to whether they were applicable to metal or wood. It is probable that in most cases in the inspection of metal

bridges, the general appearance and judgment of the inspector is the criterion as to whether actual measurements are necessary.

A decidedly major portion of the replies indicate that recommendations as to repairs and renewals are made at the time of inspection and are recorded with the notes, but in the case of metal bridges, it is more than likely that such recommendations are appended to the inspector's report after mature consideration of the conditions reported.

We find that in most cases the inspection notes are copied before being filed and that disposition of the notes is extremely diversified. No general practice regarding their disposition can be offered as representative of the majority of the roads. In some cases careful calculations are reported as being the method of determining changes in the carrying capacity of the structure, but in other cases no such calculations or other investigations are customary. Almost all carriers report the practice of comparing records of previous inspections with conditions found in an effort to determine the progress of deterioration.

Replies to the questionnaire apparently warrant the statement that on almost all roads the inspector has authority to order repairs or replacements, but we are inclined to believe that this authority is customary only with wooden bridges, since the repair, reinforcement or replacement of the metal structures is ordinarily the result of a definite program of elimination or reinforcement and therefore cannot, on account of its being a matter of policy, be delegated to the inspector. We are, however, justified in making the statement, at least with respect to metal bridges, that the practice of making recommendations to some other officer is more general than any other method. A few roads report the maintenance of an established system of determining by prescribed limitations in stress as to what action should be taken on the inspector's recommendations. This cannot, however, be said to be the general rule.

While different courses of movement of the inspection reports are described in the replies, it may be said that before definite action is taken their consideration is strictly a matter for the bridge engineer with whom the reports are finally lodged.

Few, if any, special forms are used in reporting to superior officers the results of the inspection as embodied in the field notes. The committee received meagre suggestions as to the matter of the general conduct of the inspection and the best way of securing the requisite results therefrom.

Wooden Bridges

Entirely different results are to be expected from the effects of climate on wooden bridges than with metal structures. From the replies received, we are unable to formulate any definite statement as to the general effect of climatic conditions in the periodic inspection of wooden bridges. Railroads in the same territory differ as to the frequency of inspection. A tabulation of the returns shows the periodicity of inspection and the percentage of the total mileage reporting under that periodicity as follows:

Annually	41.55 per cent
Semi-annually,	32.22 per cent
Three times annually	5.95 per cent
Four times annually	2.62 per cent
Six times annually	13.11 per cent
Monthly	4.55 per cent

Much difficulty is experienced in harmonizing rank and authority with the titles of officers on the various roads in the country. This is especially true with respect to those officers having authority in the bridge and building department. The most frequently used titles are bridge engineer, superintendent B. & B., supervisor B. & B. and master

carpenter. Perhaps we are justified in stating that the officer most often made responsible for bridge inspection is either the supervisor or superintendent of bridges and buildings.

Nearly 75 per cent of the mileage represented in the replies customarily uses the motor car as a means of conveying the inspection party over the line, while only about 21 per cent uses regular or special trains.

The tools generally used for the inspection of wooden bridges consist of a special inspection bar and testing auger, although in some cases a chisel and brace and bit are added to the tool equipment.

Regular forms for recording inspection notes in the field are used by 85 per cent of the mileage represented in the returns to the questionnaire. The condition of each member is recorded separately by lines aggregating about 70 per cent of the total mileage reporting, but we are inclined to believe this pertinent to metal bridges only. Actual measurements are reported as being taken by 52 per cent of the reporting mileage, while general appearance and judgment are used by the remainder, viz., 48 per cent. By far the larger portion of the lines record in the notes recommendations as to repairs and renewals at the time the notes are taken.

The committee desired particularly to obtain information as to the forms of field notes and their disposition after the inspection was completed. The results of our inquiry show that while 85 per cent of the reporting mileage use regular forms for the reports, there is no uniformity in the manner of handling the notes when completed or the final disposition thereof.

As was to be expected, by far the larger portion of the railroads replying to our inquiries make a practice of consulting and comparing previous inspection records in order to determine the proper recommendations for action in the matter of repairs and renewals. It is scarcely possible in the case of wooden bridges to determine with any degree of satisfaction by calculation a change in carrying capacity due to deterioration or decay of timber. Therefore, while several railroads report that computations are used in such determinations, we are of the opinion that this course applies more particularly to metal rather than to wooden structures.

General practice is about evenly divided as to giving authority to the inspector to order repairs or replacement in distinction from simply making recommendations as to these matters.

In consideration of the foregoing briefly outlined data received from the various railroads, a survey of the conditions confronting the nation during the past year and an analysis of developments which may reasonably be expected in the near future, the committee begs to submit its conclusions as follows:

Conclusions

(a) While the country was in a state of war, unprecedented conditions confronted the railways, and these conditions among other things necessitated extensive recourse to substitute plans, alternative methods and unusual expedients. Now that the war is over we find ourselves citizens of a nation with a greatly depleted treasury and a huge burden in the shape of a national debt of staggering proportions. There never was a time in the history of our people when there was so great a need of economic and careful management. It may be said without fear of contradiction that the greatest urgency of the times is for conservation of both labor and material in order that the demands for the production of the necessities of life and of the requisites for industrial and commercial enterprises may be met. It therefore devolves upon us as citizens to use to the greatest extent possible the means we have at hand for accomplishing useful purposes and thus conserve resources which in normal times might be used with impunity. In other words, it behooves us to get out of materials every vestige of use and service-

ability which they possess. When the question of safety to life and limb is involved and protection against loss and damage to property is the governing factor, this conservation can best be obtained only by extreme vigilance in the way of careful and rigid inspection, for after all is said and done it is the behavior in service of men and materials which affords the final criterion for their replacement or renewal. We therefore believe that the matter of bridge inspection is one of the most important phases of work which confront us at the present time.

(b) We conclude that in addition to the patrol of railway lines for emergency hazards which are likely to present themselves at any moment, a systematic plan of thorough bridge inspection should be inaugurated on every railroad regardless of its extent. This inspection should not in any event be undertaken at more infrequent intervals than annually and preferably it should be made semi-annually. There are many cases in which, dependent upon the volume of traffic, material will serve for an additional period of six months when there is doubt as to its serviceability for a year. Accordingly as to whether annual or semi-annual inspections should be inaugurated, consideration should be given to the customary length of time ensuing between the date of inspection and that as of which the recommendations of the inspector can be carried out.

(c) Mention has been hereinbefore made of the diversity of duties and authority of officers having the same or similar titles with the various railway lines. We are, therefore, unable to suggest, at least by official title, the officer who should be designated as the person in charge of or responsible for the actual work involved in bridge inspection. Where the railroad is large enough to justify the maintenance of a regular inspection organization, then obviously the designation of the person to make the inspection of bridges is comparatively a simple matter. The difficulty is primarily to be found in roads of moderate size where an officer must be detached from his regular duties to take charge of inspection. For metal bridges a person particularly qualified by technical education and training should be selected, but in the case of wooden bridges where continued serviceability is not so much a matter of mathematical calculation, it would seem that a person of mature judgment and experience is highly desirable. Accordingly, without further suggestion, we leave open as a matter of preference for the individual lines the designation by official rank and title the proper officer for making the inspection.

(d) Since the actual field work connected with the proper inspection is necessarily slow and laborious, it is not only advisable but quite necessary that the best possible means of taking the inspection party over the line be afforded. Because of the expense incident thereto, the inconvenience of alighting from and boarding standard train cars, the abnormal consumption of time in stopping and starting, regular or special trains used for inspection parties do not meet the requirements, except perhaps in isolated cases where bridge structures are few and of unusual magnitude. The gasoline motor car appeals to us as very decidedly affording the best means of locomotion for the inspection party.

(e) Many inspectors have their pronounced ideas as to the kind of tools best suited for their work. We think that the preference of the inspector in this matter should be followed and that any special form or size of tool or equipment desired should be furnished without hesitation, even to the extent of having them made expressly for the purpose if necessary.

(f) There can be no doubt as to the necessity for regular forms designed especially for bridge inspection purposes. The cost of these is indeed trifling when compared to their inestimable value in insuring a satisfactory record. We believe that extensive study given to this phase of the matter will be amply repaid. It seems to us that just

as in the case of inspection tools or in the method of conveying the inspection party over the line, every facility possible should be afforded to the inspector. Therefore, forms for the taking and the recording of notes in the field should be comprehensive and complete as to detail in order to assist the inspector in his work which at best is apt to be trying, if not in fact, exceedingly difficult. The taking of any kind of notes in the field is essentially a mental picture of observed material conditions, and any device which will serve to assist in the portrayal of actual conditions should be supplied. Accordingly we think forms not only complete and comprehensive in substance, but of convenient size and shape, necessary. We had hoped to receive among the various samples submitted to us at least one form or set of forms which we could recommend for adoption. In this, however, we were disappointed, and of all those received, we cannot consistently suggest any as a model. As a result we conclude that each railroad should make a study of its own particular conditions, its form of organization and its customary method of handling such matters and then as a result of this study design special forms to suit its requirements. It will be apparent that on account of different inherent characteristics, the forms for metal bridge inspection require different treatment than those for the inspection of wooden structures. We think it therefore proper to advise the adoption of separate forms for these two classes of structures.

A decided advantage is secured in having notes made in manifold in the field, thus obviating the necessity of transcription in the office and still preserving the distinctly desirable feature of having both the inspector and his superior officer supplied with an exact counterpart of the record as it was made in the field. However, if it should be deemed impracticable or apparent that the taking of the notes in manifold will in any considerable degree embarrass the inspector in the actual work or impede the progress of the inspection, then manifold copies should be foregone. In addition to forms for the actual taking of inspection notes and the recording thereof, we also suggest for thorough consideration the advisability of specially designed forms for the transmittal and summarization to superior officers of the results of the inspection, and such forms we believe will prove valuable in the preparation of a working program of repairs, renewals and replacements.

(g) Since it is difficult to perform simultaneously the actual details of investigation, such as sounding, tapping, boring or measuring in the different parts of the structure and to record the results in the notes, we conclude that the inspector should be accompanied by such assistants as may be necessary to effect a rigid examination. These assistants need not necessarily be officers and can usually be selected from the employés of the bridge and building department. About the only requirements for competent assistants are normal physical activity and average intelligence and alertness. We suggest that such method of inspection be pursued as will reveal beyond all question the exact condition, and to this end any testing, calculation and measurement necessary should be made.

(h) It is difficult to account for the fact sometimes observed that one member of a bridge is in a different condition from a similar member of equal age and identical character of material. If this fact prevails to any great extent, then we are of the opinion that the condition of the members should be reported separately, but otherwise they can just as well be reported by groups or classes. We are unable to advise further in this phase of the matter because of the fact that, especially in the case of wooden structures, the different groups or classes of members are usually constructed of different kinds of timber and also because of the fact that there is a great diversity in the practice of effecting repairs and renewals on the various railroads.

(i) With metal bridges it will probably be necessary to make actual measurements for the determination of waning serviceability, especially if there is reason to believe that deterioration had to any extent taken place since the previous inspection. Measurements are particularly necessary in the case of a structure which is nearing the point of retirement on account of age, deterioration or over stress of material approximating permissible limit of stress for such material under actual load. In the case of wooden bridges, we are unable to see how measurements carefully taken are always warranted, for usually the waning serviceability of timber is a matter of approximation, experience and judgment. Consequently our views as to this are that the experience and judgment of the inspector should be given the greatest weight in considering the adoption of his recommendations.

(j) The distinct advantage of having the inspector record his recommendations as to repairs and renewals at the time of the inspection is apparent. We therefore suggest that this practice be made universal. We also believe that logical recommendations cannot be formulated without consulting with previous inspection records. This, however, would seem to be a matter of personal fitness of the inspector, and the practice should be cultivated, for what has taken place in the past must necessarily afford some idea of what may be expected.

(k) The authority of the inspector should be broad enough to include the prerogative of ordering immediate repairs through the nearest responsible officer in case the exigencies of any particular case warrant such action. This would of course only result from the discovery of a condition too hazardous to continue unabated until corrected with the customary program of repairs and renewals. Ordinarily, however, the policy of the company or form of operating organization will dictate that recommendations of the inspector be made to the officer in charge of the maintenance of bridges and culverts, if the inspector himself is not that officer.

(l) We do not see how any prescribed limitations in stress under actual loading can be inaugurated for determining the amount of repairs and renewals in the case of wooden bridges, for there are no data extant showing definitely the strength or dependability of timber as influenced by age or state of decay. With metal bridges, however, the question is entirely different and it is our suggestion that if possible to do so, each railroad establish certain limits in stress beyond which loading must not be increased in their production. This is properly a function of the bridge engineer and no general rule can be suggested at this time for adoption by the different lines.

(m) The committee believes that the program and general conduct of inspection should be left to the discretion of the individual railway, but we strongly favor the recording of all inspection data in the field at the time of the actual investigation and that these data be used for all desired purposes without their transcription or copying if possible. We also strongly favor the plan of having a counterpart of all notes, reports and recommendations filed in their original form in the inspector's office in such a way as to be readily accessible. In any event, all papers and records in any way connected with the inspection should rest finally in some one office file so that all the facts pertaining to any phase of the matter can be produced without the expedient of consulting more than one record file.

These conclusions may be summarized and enumerated in the form of recommendations thus:

1. A well organized plan of thorough and periodical bridge inspection should be in effect on all railroads. Inspection should preferably be made semi-annually and in any event not more infrequently than annually.

2. The inspector should be particularly fitted by training and ex-

perience for the work, technical education and training being requisite for metal bridges and both judgment and experience for wooden structures.

3. Motor cars afford the best means of conveying the inspection party over the line.

4. Such tools, either special or standard, as he may consider useful for his purpose should be furnished the inspector.

5. Special inspection forms for taking and recording notes are essential. Adequate provision should be made for reporting the condition of bridge members individually or by groups and classes, dependent upon the facts disclosed by the examination.

6. Sufficient assistance to insure the thorough and comprehensive examination of structures inspected should be supplied.

7. Where necessary to determine the extent of the deterioration, actual measurements of members should be made.

8. Recommendations of the inspector as to corrective measure which should be applied to observed conditions are not only desirable but practically necessary. These recommendations should be recorded in the notes at the time of inspection and upon its completion should be followed up through proper channels for necessary action thereon.

9. The inspector should be vested with authority to order through proper channels the correction of any imminently unsafe condition discovered.

10. Prescribed limitations in stress should, if possible, be established, especially for metal bridges.

11. The general program of inspection can best be formulated by the individual railroad and must needs be developed by a consideration of the operating organization in vogue, methods of effecting repairs and renewals and the number, magnitude and character of bridges maintained.

12. At least one complete counterpart of all notes, recommendations, records and papers pertaining to the inspection and corrective measures applied as a result thereof should be kept in one file of ready access.

Respectfully submitted,

Arthur Ridgway,
J. S. Huntoon,
J. H. Johnston,
Herbert C. Keith,
G. W. Rear,
J. L. Winter,
Committee.

In subscribing to the foregoing report Mr. Keith states that—

Although accepting in the main the report as submitted to the committee for approval, he must take exception to the opinion expressed in the preamble under the heading "Wooden Bridges," where it says "it is scarcely possible in the case of wooden bridges to determine with any degree of satisfaction by calculation a change in carrying capacity due to deterioration or decay of timber. Therefore, while several railroads report that computations are used in such determination, we are of the opinion that this course applies more particularly to metal than to wooden structures"; and to the conclusions drawn therefrom, expressed in paragraph (c) that "in the case of wooden bridges—continued serviceability is not so much a matter of mathematical calculation." Mr. Keith maintains that it is as simple a matter to determine the capacity of timber structures as that of those made of steel or iron. Accordingly, he thinks that Recommendation 10, that the limitation of stress should be prescribed, might apply equally to steel and timber.

He also objects to the conclusions drawn from these assumptions and their limitations as expressed in paragraph (c). "For metal bridges a person particularly qualified by technical education and training should

be selected, but in the case of wooden bridges where continued serviceability is not so much a matter of mathematical calculation, it would seem that a person of mature judgment and experience is preferable." Also to the limitations under Recommendation 2. He believes "that the Inspector should be particularly fitted by training and experience for the work," and that technical education and training, and also judgment and experience are requisite for both metal and wooden structures.

APPENDIX "A"

THE AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION

Denver, Colorado, February 23, 1919

Dear Sir:

The committee appointed to submit at the next convention of the Association a report on "Methods of Bridge Inspection Under Present Conditions" earnestly request your coöperation to the extent of responding to the following questions.

It will be quite satisfactory to send direct to the Chairman replies numbered to correspond with the question without repetition thereof in your response.

1. Name of Railroad.
2. Roughly approximate mileage by states to which replies are applicable.
3. How frequently are bridges inspected? If not continuously state time of year inspections are made.
4. Official title or rank of officer in charge and number and kind (Class of Employé) of Assistants in inspection party.
5. State method (means of locomotion) of conveying inspection party over line.
6. What inspection tools and equipment are used?
7. Are regular forms used for taking and recording notes in the field? If so, please send copies.
8. If no regular forms are used please state usual manner of making notes especially with reference to:
   (a) Location, Type, Span and General Information;
   (b) Substructure;
   (c) Superstructure;
   (d) Floor.
9. Is condition of each member recorded separately, or all of those of a kind grouped and recorded as a class?
10. What methods of inspection are used? (Give such details as may seem desirable.)
11. Are actual measurements taken to determine amount of deterioration or decay, or is such determination based on general appearance and judgment?
12. Are recommendations as to repairs and renewals made at time of inspection and recorded with the notes?
13. Are inspection notes made in manifold or copied, and in what office are they filed? (State customary disposition and advise if used in succeeding inspections.)
14. What calculations or other investigations are made to determine change in carrying capacity due to deterioration or continued service?
15. Are comparisons made with previous inspection records to determine progress of deterioration or waning serviceability?
16. Does inspector have authority to order repairs, reinforcement or replacement, or does he make recommendations to some other officer, if so, to whom?

17. Do you have an established system of determining by prescribed limitations in stresses under actual loading or otherwise as to what repairs and renewals should be undertaken and if so please describe in full.
18. To whom are inspection reports made? (If any forms are used for this purpose please attach copies and if no forms are used outline character and extent of report.)
19. Please favor the Committee with any suggestions you may have which are not covered by foregoing questions. Your recommendations as to
    (a) Program and General Conduct of Inspection;
    (b) Collection and Recording of Inspection Data;
    (c) Disposition of Data, Reports and Recommendations;
    will be greatly appreciated.

Yours truly,

J. S. Huntoon,
J. H. Johnston,
Herbert C. Keith,
G. W. Rear,
J. L. Winter,
Arthur Ridgway, Chairman,
Assistant Chief Engineer,
Denver & Rio Grande R. R.,
Denver, Colorado.

DISCUSSION

(Methods of Bridge Inspection)

The Chairman:—Mr. Ridgway will open the discussion and give us a synopsis of the report.

A. Ridgway:—Mr. President, I want to acknowledge before the members of the association the consideration which the members of the committee gave to this subject. It was difficult to get opinions because we were scattered to the four corners of the earth, as it were—one in Canada, one in New York City, one in Florida, another on the Pacific Coast, one at Detroit, and myself at Denver. I wish to thank the members of the committee for the consideration which they gave to the report. I think that since you have before you the full report it will be unnecessary to read any portion of it.

Secretary:—Are there any important points that you ought to bring out?

A. Ridgway:—I am not sure whether the association ought to take any official action regarding the recommendations and conclusions in the report. I think perhaps that should be left to you. The note reporting some conclusions with which Mr. Keith could not agree, has been slightly changed. I believe that was printed before later advice had been received from Mr. Keith, and I am of the opinion that Mr. Lichty has a copy of that.

(Note: Mr. Keith's revised conclusions appear at the end of the report, just ahead of Appendix "A.")

It seems that this report has not been circulated very generally among the membership and it may be well to review briefly the vital points. The first step, of course, in our work was to canvass the situation in an effort to ascertain what methods of bridge inspection were being followed. Accordingly, a questionnaire was prepared, and this questionnaire appears at the end of the report. The situation with regard to bridge inspection was so complicated that it necessitated rather an involved questionnaire. It was sent to some 100 railroads on February 23. We received about 40 replies, representing about ninety thousand miles of railroad. We were disappointed in many of the things we started out to do. We found out that we could not classify

the different methods. We could not recommend anything very definite because of the fact that there was so great a divergence of practice, and because of the fact also that it seemed that members might be constrained to follow recommendations, whereas the methods they were accustomed to using might be the best for their purposes.

Briefly, the first two or three pages discuss the replies to the questionnaire. The conclusions of the committee are drawn from a study of the situation, and also from the replies received. It was thought best to condense those conclusions somewhat in the form of recommendations for your use. What we hoped to do was to present something which you could use in your work. Perhaps we have failed. At least we have tried.

The Secretary:—If you have no objection, I would like to read the first page and a half of the report. I think it will help us in our discussion.

G. W. Rear:—Having had something to do with the preparation of this report it appears to me that it will be necessary to read all of it. It is an involved subject and it is not altogether clear in my own mind yet. Besides, those present have just now received copies. I don't think it is possible to discuss it or even get an intelligent idea of what is in it except by reading it.

(The report was then read.)

A. Ridgway:—We received some good forms and I am sorry that we cannot present them to you, but this association would have become bankrupt if we had tried to reproduce them. I don't believe there were any two alike, and I fear there weren't any more than two or three that followed the same general plan.

G. W. Rear:—As a member of this committee we found it very hard to get out any report at all. The committee was scattered all over the United States. Each one, of course, felt that he ought to do his share and it was only, really, when we got into some little arguments that we got any work done at all. There are some little technical details that all of us are not agreed on, but I believe that all did agree far enough to sign the report. For myself I do not agree with the division of the bridges between Metal and Wooden Bridges. We compromised on an explanation that a wooden bridge really meant a timber trestle, but some of us are still blessed with a large number of wooden trusses. We ourselves have over one hundred, with some spans over 200 ft. long. It would seem to me that the

real line of demarcation that should actually be drawn is between truss and stringer bridges. We have iron and wooden stringer bridges and they are in a class by themselves. I believe that the iron truss and the steel and wood trusses all group around the same style of a bridge, and should be treated accordingly. I think that the sub-titles "Metal Bridges" and "Wooden Bridges" should be divided to read "Truss Bridges" and "Stringer Bridges."

R. H. Reid:—I think the distinction between metal and wooden bridges is good; it is natural. Wooden bridges are subject to different deterioration than metal. Wooden bridges deteriorate from the day they are completed, while metal bridges, if properly protected and painted, remain in practically a state of perfection for several years at least. After that time the wear and tear of traffic and a certain amount of deterioration that sets in, even in the face of painting and ordinary care, begins to have its effect on the metal. Of course, if metal bridges are not properly painted, deterioration starts at once, and progresses very rapidly. Metal bridges require a different kind of inspection from timber bridges. That is, an inspector may be competent to inspect and recommend repairs for timber bridges and yet he may not be competent to recommend repairs for, or make an inspection of, metal truss bridges. Ordinary stringer bridges, such as I-Beam stringers are, of course, in their conditions of service, somewhat similar to wooden stringer bridges. They do not have the complicated stresses, the rivets to get loose, pins to bend and break, and other things like that, but the composite metal bridges, trusses, lattice bridges, and things of that kind require higher experience and more ability than the inspection of the ordinary wooden trestle bridges. Wooden truss bridges require more careful inspection than wooden trestle bridges, especially if they are not covered. The web members of a truss and the chord members are peculiarly subject to decay. In a packed chord, especially if packed with wooden keys, water gets in and starts decay from the inside. I found on our own line that a wooden truss bridge might look good on the outside, yet, by taking a small auger and boring into the chords and into the packing keys and at the foot of the clamps, we found dry rot in certain cases. In some cases it was enough to warrant the elimination of the bridge. In the case of ordinary wooden trestle and wooden stringer bridges the appearance of

the structure itself generally shows whether it needs repairs or renewal. There are times, of course, where you can't depend entirely on appearance. Caps on piles may look good on the outside, and have dry rot on the inside. Stringers may look good on the outside and have dry rot or wet rot on the inside. While to an experienced inspector the appearance of the bridge will go a long way toward telling its condition, it is not always infallible. Unless a man is thoroughly posted on each bridge on his territory, and actually knows the conditions, he must generally have to go beyond appearances in making a thorough and competent inspection.

G. W. Rear:—We have about one hundred wooden Howe truss bridges and they require much more inspection than any metal bridge that was ever built. They also require a high degree of technical knowledge as to just what a wooden truss is supposed to do. The wooden truss is the structure we have to inspect the most, and the most carefully; we not only have to inspect it for its physical condition but also for its capacity. About every three or four days we are called on to determine whether a certain type of locomotive can run over such a branch. The wooden truss bridge is a great burden on the man who has to maintain a large number of them.

The Chairman:—I believe that we all have pretty well defined ideas as to whether we ought to inspect our bridges once or twice a year, or oftener. Let us have your ideas.

C. W. Wright:—Twice a year or three times a year is not enough. I don't believe that you ought to have a bridge, particularly a wooden bridge or a truss bridge that is not inspected at least once every three months. It is the displacement of material as much as the decay. I believe that four times a year is not too often.

P. N. Watson:—On our road we have general inspectors who inspect bridges probably twice a year on the system, but I have men who inspect all bridges once a month. We have several wooden truss spans, a few pile bridges, and many steel structures. We also have several lattice wooden bridges, and if any members here can tell what they will carry today or next month, he can do more than I can, but we inspect them often and maintain them as near right as we can. I think that monthly inspection of such structures is absolutely necessary.

The Chairman:—How many inspections do you make a year

to ascertain the work to be done on them in the shape of renewals and repairs?

P. N. Watson:—Probably two a year.

The Chairman:—The idea of your monthly inspections, then, is simply to be sure of keeping them safe.

A. Ridgway:—The committee's reason for putting that paragraph in was that the committee on subjects wanted us to report on methods of bridge inspection for current maintenance for repairs and renewals. We all know that our bridges are inspected more frequently than every six months or once a year, but this is the inspection to determine the year's program, as it were, for repairs and renewals. Almost every railroad has some kind of a budget, and it is necessary to have some idea as to the amount of work that is necessary for the next year in order to make up the budget. One can't get that by running out every two or three days and taking a look at the bridges. He has to have one real inspection, and at this inspection he must take enough notes, and secure enough information to make up the budget. Those who have had anything to do with the budget know that they don't always get on all the work that they expect to get, and that really ought to be on. Nevertheless, the inspection is the only basis that one has to make up the budget from. Consequently, I think that the recommendations of the committee ought to be allowed to stand in that the railroads of the country have their choice as to whether they will make this general inspection once or twice a year. Every road knows, of course, how often it can make it and what will suit them best. If there is no further objection, I will read the next section. (Reads Section c.) May I read Mr. Keith's exception to that? As I stated before, the notes at the end of the report do not apply as we have received later advice from Mr. Keith. Mr. Keith states that "In subscribing to the foregoing report, although accepting in the main the report as submitted to the committee for approval, he must take exception to the opinion expressed in the preamble under the heading 'Wooden Bridges,' where it says 'It is scarcely possible in the case of wooden bridges to determine with any degree of satisfaction by calculations a change in carrying capacity, due to deterioration or decay of timber. Therefore, while several railroads report that computations are used in such determination, we are of the opinion that this course applies more particularly to metal rather than to wooden structures.'"

Mr. Keith maintains that it is as simple to determine the capacity of a timber structure as of those made of steel or iron. Accordingly he thinks that recommendation 10 " that the limitation of stress should be prescribed " might apply equally to steel and timber. Steel is a metal and has little affinity for common chemical elements. Wood is a vegetable, susceptible to many structural changes after the tree is cut. Steel is manufactured and subject to inspection during the process of manufacture. Defects in growth of wood cannot be foretold accurately. Steel is uniform in structural characteristics. Wood is subject to so many natural and artificial conditions that any prediction as to its behavior can't be confined to very narrow limits. If at all, steel loses its strength through deterioration very slowly. On the other hand, from the moment the tree is felled deterioration starts and follows no regular or mathematically certain course; hence, the limits of stress for steel can be readily fixed within rather narrow bounds while the limits of stress for wood, even when new, are the average of a wide range of values. We all know that, being a homogeneous material, the remaining life or serviceability of steel can be readily determined. In fact, it is apparent. We say the net section is the same strength per unit as the original section; therefore the remaining serviceability left in steel is very evident from inspection. Wood is entirely different. The depth of decay in the stick is really no criterion for what is inside—what unit stresses the remainder of the stick will stand. We find also that the strength of timber varies for different species of wood, and even for different sticks of the same species. The season checks and other weathering developments exert an influence, and the position of the stick in the completed structure also must be considered. Those things are really as great factors in determining its carrying capacity as the depth of decay. Therefore we say that with all these complexities and inter-relations of defects, and the deterioration in the wood, the wooden structure is not as susceptible of mathematical demonstration as that of steel, so we don't advise prescribed limitations of stress for inspection purposes. To do this we think it would require really ultra-conservativeness, putting the stresses very low. If not, there would be some cases in which the inspection would result in passing it up and probably approaching very near the danger line.

F. E. Schall:—It seems to me this discussion needs to be

based on the bridge inspection for the purpose of the annual budget and renewals. We are having a report here that doesn't cover the ground it is supposed to. The heading says " Methods of Bridge Inspection Under Present Conditions," but it doesn't define. That is simply a question of finding out how much money we will have to provide for next year's work. Now we will either have to change the heading or change the report in order to get it right. I personally take the position that the metal bridge, under certain conditions, will require just as much inspection as a wooden bridge. It all depends upon how much the bridge is overloaded over and above its original design. Where is the bridge located? How much has the salt brine eaten away the metal? Perhaps you may have to go to that metal bridge twice before you go to the wooden bridge. Now when I speak of a wooden bridge, I don't mean truss bridges. We find that we can usually help ourselves with a wooden bridge, but we find ourselves in a different position with a metal bridge when it is once over stressed to a point that is near the limit of safety.

The Chairman:—You think, then, that we should have a different inspection for metal structures than for wooden bridges?

F. E. Schall:—Not a bit. You can't draw a line. It depends on the traffic, on whether the bridge is overloaded, and on the design of the bridge as to whether it suffers under the load by its peculiar construction and limitations of that kind.

The Chairman:—Don't you think that the strength of a metal structure can be determined by calculations on the remainder of a section, whereas that is not possible with a wooden structure?

F. E. Schall:—You can figure those stresses down so far, and no further.

G. W. Rear:—We foresaw the very difficulty of which Mr. Schall is now speaking. You will find our position in the second paragraph, the opening of the report. We assume that this inspection is for waning serviceability and not for the detection of dangerous things which will arise probably in emergency cases. I think that farther along in this report we have probably covered this. We did come to the conclusion that for metal bridges there should be some absolute limit beyond which no load should be permitted to go, and that nobody could crowd one to go over that limit.

The Chairman:—Mr. Rear will continue reading the conclusions. (Reads paragraph 1 of conclusions.)

Maro Johnson:—The working season is limited to six or eight months. If there is an inspection in the fall to make up a program for the work starting the next spring, it is not clear when the work reported on in the spring inspection is performed. Of course, a bridge may deteriorate considerably in six months, but that feature can be taken care of by the monthly inspection.

G. W. Rear:—The committee has no objection, of course, to anybody inspecting the structures semi-annually or annually. The only idea was to express the opinion of the committee, and some of the committee thought six months was the proper period, although it would appear that an annual inspection is probably the most common. (Reads paragraphs 2, 3 and 4.)

The Chairman:—There ought to be some comment on the tools to use.

R. H. Reid:—On our line we use a pointed steel bar of ¾-in. round steel, with a point about two inches long on one end. On the other end is a knob, something like a door knob in shape, for sounding timber. We use the sharp end to get into the sap-rotten pile or timber, and the other end for sounding timber and piles which apparently are good, and yet sometimes may have dry rot on the inside. By striking the timber with the knob end of a bar of that size, you can tell if it is hollow or sound, and the experienced workman can tell about how much sound timber there is on the outside of the rotten inner core for the timber with a real thin shell will have a different sound than the timber with a shell of considerable thickness on the outside. We have also used a ⅜-in. auger for boring into the timber for decay which could not be detected readily by either a pointed bar or by sounding. Sometimes we bore into the chords to determine whether there is dry rot in the timber, when we couldn't tear the chord to pieces with a pointed bar, and couldn't always tell by sounding. Those tools are the ones that we have depended on entirely for our inspection of wooden bridges. For the inspection of metal bridges, and especially where there is heavy rust, we use the steel bar for scraping off the rust and determining how badly the structure is rusted, and sometimes we use the head of the bar for sounding rivets to determine if any of them are loose. If the riveted structure has been in use for any par-

ticular length of time a loose rivet will show itself by the red around the rivet. If any other part of the riveted structure, the steel angles, or any other parts are loose, they will show the rust from the working and churning of the steel. In a heavy steel bar sometimes one can't tell it, and the hammer is a good tool for breaking off the rust scale. That scale forms on metal bridges all the way from the thickness of paper to ½-in. I have seen rust scale on those bridges fully half an inch thick that has been allowed to accumulate for the lack of proper inspection.

(Mr. Rear reads paragraph five, and continues:)

I will venture to say if there are 160 men here there are at least 160 different forms, and probably none of them are ideal. The American Railroad Engineering Association got out some standard forms a few years ago, one of which is very good. After long experience in writing down inspection reports I have found the narrative form by far the best. I have examined all of those books where you mark down crosses and X's, and there is nobody except the man who writes them down who has any conception whatever as to what they mean. He may intend to say that the structure was new last year and do it in circles and squares, but for a man to write down the way it appears to him in the English language, without any shorthand, is the very best method. Then there can be no question about it, and if the inspection report happens to get into the hands of anybody else, he can see pretty nearly what it is.

On our railroad—and I think that is what ought to be done on all railroads—the inspection party inspects everything as they go along, whether it is a bridge, trestle, cattle guard, pipe or wooden box. They note on the inspection report that it is still there, and give some idea of its condition at that time.

We used to use forms with carbon copies. A man would have a pad fixed up with carbon copies and just about the time he wanted to write something on it he would find that the wind was blowing and he was at the bottom of the page, and he would have to change the carbon sheets. As a result we got up a book of another character.

G. W. Andrews:—I understood Mr. Rear to say that of the great number of inspection reports, probably one for each railroad represented here, none of them are good. We think we have a very satisfactory form. We don't care whether our form is satisfactory to anybody else, but we do know that it is satis-

factory to us, and it keeps us in touch with the bridges. In explanation I might say that each of our divisions has one or more competent bridge inspectors. Those bridge inspectors are furnished with books of forms made just as simple as possible, and in which are given the bridge number, the date of inspection, and a column for remarks showing the character of the work or the condition in which they found the bridge. That is drawn up in triplicate, one copy of which goes to the master carpenter, and one to the division engineer. The division engineer enters it in a card index, of which we have three classes—for the wooden structures, for the steel bridges built before 1890, and for the steel bridges built since 1890. When anything extraordinary is found that requires attention from the general office or from the office of the engineer of bridges, in the way of strengthening, a monthly report is sent in, or, if found serious, a report is sent in immediately, when an inspection is made from either the office of the general superintendent of maintenance or from the office of the engineer of bridges, or usually by both. Plans are drawn, orders placed in the shop for the necessary material and it is fabricated and sent to the site where it is installed.

Mr. Rear reads No. 6, No. 7 and No. 8.

R. H. Reid:—On the New York Central the inspection is made by the supervisor of bridges himself. We have a bridge inspector on each division. The divisions run from about 400 to 900 miles. The determination of any repair and renewal work to be done is made following the general inspection trip of the supervisor of bridges which is made twice a year. We use a loose leaf book with 6 or 8 pages, 3¾-in. by 7-in. We have a bridge record written on that. We tried the typewritten form suggested by Mr. Rear, but while it is convenient for getting it out and multiplying the copies, it didn't make it so compact, and our inspectors and men generally preferred the smaller book, so they write up their own books, and I write mine. I write up my inspection book about once every five years, but I correct it after every weekly report and it is the official bridge record of the road for it is from that book that all our bridge calculations and our bridge history is secured. The inspection notes are made at the end of each sub-division for each branch. The records are written upon the regular pages and the inspection notes are made on single ruled sheets at the end. After each year the inspection

notes are removed and filed, so we have a permanent file of inspection notes on our bridges for years back.

In connection with the valuation work the inspection records have been very convenient. Our valuation people have come to us time and again to find out what work we have done on certain bridges during certain years. The bridge record itself, as I said before, is written up about every five years, and the old records for the bridges are filed away, so they are always available as history. In my book the inspection notes for each division are always at hand, and are always carried in records of the previous inspection with it on the general inspection trip. We have the previous inspection record with us and in that way we have a follow-up system so that any defect that is noted in the bridge, if it is one that doesn't require immediate repairs, can be followed up on succeeding inspections and developments noted. In that way we can sometimes carry structures longer than would be possible with more infrequent inspection, and without the follow-up system of keeping track of defects.

C. F. Estes:—We have a somewhat similar system on the Union Pacific. We keep our notes in book form in the office where we have access to them. Anything that is found to be of an emergency character is done immediately on the supervisor's request. The other work is followed up very closely as soon as we can get the necessary authority. A record of each inspection is always kept in the office where it can be gotten at all the time.

The Chairman:—This paragraph has to do with the method to be used in getting the inspector's recommendation before the proper officer, and the resulting action.

A. Ridgway:—The idea in drafting that particular clause was just this: We all know that the man on the ground is the best man to make recommendations to correct the conditions which he has observed. His suggestion has greater weight than if anybody else made those recommendations. If he simply reports the conditions without saying what ought to be done, the supervisor or the man in charge is apt to lay out a program of work for that bridge slightly unnecessary or perhaps not sufficient to take care of conditions. It is really the man on the ground whose recommendations should be taken, and whose recommendations bear weight.

T. B. Turnbull:—I am talking from the standpoint of a small railroad because I am interested in a small railroad and

am connected with one. I am the superintendent of bridges and buildings, the man who makes the inspection, and as it is only a short line—a little over 300 miles—of course one gets familiar with every structure on it. The superintendent of bridges and buildings has authority to make all repairs necessary to any bridge. He makes the inspection in the fall of the year, not only for the renewal of the bridges the coming year, but for any improvements that he thinks ought to be made. Improvements are only made upon the authority of the chief engineer. As a matter of course any immediate repairs that are needed are taken care of by instructions from myself and there is no question about their being taken care of immediately.

The Chairman:—The committee gave consideration that in making a recommendation for perhaps the rebuilding of a bridge, the inspector also should make a recommendation for repairs in case the rebuilding is not approved.

A. Ridgway:—I should say it would be entirely within the province of the inspector to make any recommendations he chooses. If the urgency of entire rebuilding would be apparent to the inspector, he should make that recommendation. If there is any question in his mind as to authority not being granted for that entire reconstruction it seems to me it would be perfectly proper for him to give an alternate recommendation.

G. W. Rear:—I would like to as briefly as I can, describe the method we follow. We are a railroad of considerable size, and have at the present date 715,000 lin. ft. of wooden trestles. A great deal of it is permanently temporary. We have 11 divisions, all up to a thousand miles in length, and we have the same organization on each, including a division engineer, a bridge and building supervisor and a division bridge inspector. The latter acts as a sort of assistant to the supervisor. He makes an inspection of every structure quarterly. In order to keep all the divisions on somewhat of an equal footing there are inspectors in the chief engineer's office who make a continuous annual inspection. They commence on the Texas border in the winter and work up into Washington during the summer and over into Utah and Nevada during the rest of the year. The division engineer, the bridge and building supervisor, and the division bridge inspector accompany the inspector from the chief engineer's office. They inspect everything they come to and make up their minds right there what is to be done. All parties are represented. The questions

of the renewal of small trestles or trestles of larger magnitude are settled right there as to just what will be done and recommendations are made on the inspection notes. As far as the bridge across the large stream is concerned, that is generally under consideration and anticipated four or five years before it is actually done. Each one connected with the department knows that the time is rapidly approaching when a certain bridge will need renewal, and plans are being gotten out for it.

The inspection made by this party is not absolutely final, but it is subject, of course, to review. When the inspection party gets through with the division, they make up schedules showing all the work they found necessary that should be done the following year. They also make up an estimate of how much this work is going to cost, and find out how much of it is going to be charged to capital account and how much to operating. If the amount of work required is out of all proportion to that we could expect to get authority for, the inspection notes are gone over and individual jobs here and there are picked out where a probable expenditure of a smaller amount of money might tide us over until the next year. We had a great deal of that to do during the last two or three years of the war. With such an inspection representing all sides, anything that needs actual repairing before the next train goes over it, or within a few days, all the authority of the general office and the division is right there. They can telegraph for men and material, stop trains if necessary, crib up the structure or take any action that is necessary to make the road safe.

After this schedule of work is made up, a copy is sent to the superintendent of the division that has been inspected, saying to him that this work has been found necessary for the following year and to ask for proper authority for it. The superintendent and his staff get out the necessary applications for a general manager's order and send them in. When these applications for general manager's order come in they come first to a clerk in the assistant chief engineer's office, and he checks them over from the bridge inspection report. All applications for authority that are not on the inspection report, and according to that inspection's recommendations, are taken up specially, and if necessary, special inspections are made to find out whether conditions have changed in such a manner since the inspection that it is necessary to change the recommendations.

The principal advantage of this system is that each division on the railroad is in practically the same comparative condition. There is no one division that has been allowed to run down because the individual officers on that division for the time being either had allowed the money to be spent for something else or hadn't claimed their full and just proportion and used it. The general condition of the railroad at large is much better than where the inspection is made by the division and each division spends its own money without any supervision from the general office. (Reads Section 9, also Section 10.)

It looks to me as if we ought to leave out the words "if possible," and also "especially." I believe that the prescribed limitations for wooden bridges are as Mr. Ridgway brought out. I never took down an old wooden bridge but that I found that it was in much worse condition than we thought it was. Whenever you find a bridge that is of some age and you begin to find rotten spots in it, my advice will be not to sharpen the pencil up too sharp. I remember a bridge only eight years old which we found very badly decayed. I know positively that that bridge was absolutely sound in every way at the end of five years but at the end of three years more it was in such bad shape that we didn't get it repaired and rebuilt any too soon. The length of life between absolute soundness and absolute decay is sometimes extremely short.

The Chairman:—Would you care to say what you had in mind in connection with paragraph 10, Mr. Ridgway?

A. Ridgway:—I don't feel that it is possible in all cases to fix the prescribed limit of stress. What we had in mind there was to fix the limit of unit stress per square inch of the metal left. If you are familiar with the work of the Iron and Steel Structures committee of the American Railway Engineering Association, you will know that last year it brought in a change of its impact formula. I don't know that any man can tell what the total stress is going to be in any one of those bridge members. I don't think it is possible.

G. W. Rear:—I think it is perfectly feasible for any railroad to set a figure beyond which—according to its method of calculating, it will not go. We do it with wooden bridges, wooden stringers and all kinds of structures. While it is not possible, without testing the bridge to destruction, to find out the last pound that you can put on it, it is possible to establish limits.

Mr. Rear reads Sections 11 and 12.

The Chairman:—We were talking a minute ago about establishing a limitation in stress and said a good deal about figuring what a member is good for after it has deteriorated somewhat. I would like to say that that enters into steel structures quite often, as well as others. We may have a member that figures out to carry a certain load, but the manner in which that member is connected to the lower or upper chords may be very defective, and it may not be bringing out the full strength of that member. Likewise with a floor beam, the manner in which it is connected to the chord may be very weak. I want to say that we need a good deal of mature judgment in metal structures as well as in wooden structures.

R. H. Reid:—In connection with the various other members of the bridge those points should, of course, be considered in determining the unit stresses. The actual strength of a bridge member may not be the strength developed in the body of a member. It may depend upon the net section of the angle where it is connected to the other part of the bridge. If it is an angle eccentrically connected, that will decrease the unit stresses in the member. If it is an angle connected rightly, you have a lot more strength. The net section in determining unit stress is the net section, and all those features should be taken into account.

G. W. Rear:—The only point I want to establish is that it looks as though somebody connected with the railroad should set a limit beyond which you cannot go, and when it comes to the question of operating a new type of locomotives over the line there should be something more than mature judgment to enable one to determine whether he can let it go over or not. Pressure is brought to bear every day to operate heavier power over bridges than is considered good practice. I won't say that it is unsafe, and that the bridge will break down, or that any other terrible calamity might happen, but it is bad practice, and somebody, either the chief engineer or someone else, should set a limit beyond which one cannot go. This doesn't apply especially on the wooden trestle bridges, because as a rule they are not figured so closely, but when it comes to a large bridge, especially a truss bridge, positive limits should be prescribed. That is why I say that in conclusion No. 10, where it says that " Prescribed limits should, if possible, be established,"—I think it is possible. It may be that the prescribed limits may be much smaller than

is actually necessary. As Mr. Ridgway said, the American Railway Engineering Association is changing its impact formula, but while we have an accepted formula let's use it, and stay within the limits that are given. I would like to have Mr. Schall continue on that. He is used to giving opinions as to whether certain loads can go over certain bridges.

F. E. Schall:—There is no question about regulating the different railroads to certain limits. On our system the chief engineer has charge of the structures. When a new locomotive is built a diagram of the locomotive is submitted to the chief engineer and he in turn submits it to the bridge engineer who passes on whether the engine may go over a certain line. If the engine is too heavy, in the judgment of the bridge engineer, he so reports to the chief engineer, who in turn so advises the operating department, and they either have to make the engine lighter or don't build it. That is an absolute rule that we are following very closely. Of course, we can't limit the railroad to the operation of loads for which the bridges are built. We can't fix a cast iron rule as to how much we are going to run over a certain bridge until we see it and calculate the stresses, and see how it stands up, how the various members are connected, how dense the traffic is and so forth. Bridges are not built to break down. Bridges are built to carry traffic and must be maintained. They must not be stressed to a point where they break down. You can set up a rule, and I dare say every well regulated railroad has such a rule. It is up to the chief engineer, with his bridge engineer, to adhere to the rules as to what power may be operated on that line. When you get up to the limit, then stop.

INSPECTION AND REPAIRS OF ROOFS

Report of Committee

A roof should receive as close if not more careful inspection than any other part of a building. The better and more permanent classes of roofs do not require as frequent inspection as those of the cheaper classes, but the inspection should be none the less rigid. It should include everything on the roof, such as skylights, ventilators, flashings, gutters, eaves troughs, downspouts, and adjoining masonry and brick work.

A supervisor must be careful to determine the economical limit of repairs in order to obtain the maximum life from a roof, and in so doing he must exercise due caution lest leaks occur in buildings where valuable goods are stored, resulting in serious damages. Some railroad buildings may be carried along indefinitely awaiting changes or new developments and in such cases a supervisor may be called upon to determine how best to carry the roofs without renewal with the least amount of expense until such time as the final disposition of the buildings may be determined.

A supervisor should always make a thorough inspection of the masonry and fire walls adjoining the roof, because the joints in the coping and brick work become so washed out within a few years, that water percolates down inside the wall, resulting in a report of a leak in the roof for which the roof proper is in no way responsible. The remedy is to remove the coping, repair and point up mortar joints in brick, lay in a damp-proofing course of prepared roofing, and replace the coping, pointing it up with a plastic bituminous cement. Sometimes a layer of the plastic cement is used instead of the prepared roofing. It is useless to attempt to waterproof the faces of the walls by moppings of various waterproofing compounds unless the walls are tight on top.

Flashings are a common source of leaks; those which are supposed to be permanently cemented to the brick work are rarely found thus after a few years of exposure to the elements. Large cut nails and flashing hooks should be used freely to hold the upper edges of flashings in place. The mortar used in pointing is often too soft; a rich cement mortar or bituminous cement should be employed in the repair work, applying it along the upper edge of the flashing.

In localities where melting ice during the day and frozen leaders during the night are a common experience, gutter heads are an active cause of leaks, which are rarely cured entirely. The flat metal portion of the gutter head should always be nailed down securely over the full thickness of the roofing and wall joinings; then the flat metal should be covered with solid moppings of felt and pitch, carried back at least 18 in. from the opening. If the metal is not closed in on both sides, the expanding ice in the downspout or leader will surely break the roofing away from it while it is cold and brittle. Straight runs of gutter which are improperly applied underneath roofing of various sorts frequently cause trouble of the same kind. The best remedy for leader troubles is the use of inside drains with heads like the Holt roof connection, clamped securely in place without the use of nails.

Roof coverings that depend on paint or other coatings to prolong their life are apt to become neglected, creating a liability of damage or premature loss. Especially is this so in the case of railroad buildings where frequent changes are made among officers and workmen.

Wooden shingle roofs usually have to be repaired with wooden or

tin shingles. When such roofs become old they are a fire menace, especially when they are in close proximity to coal-burning locomotives. On account of the poor quality of wire nails many shingle roofs have to be renailed within a few years after being laid. There is no doubt but that if wooden shingles are dipped in a fire-resisting preparation before being laid, and are recoated at intervals of several years, they can be made immune from the ordinary fire risks from without. As a general rule the ordinary oil paint applied to shingles after being laid is a detriment.

Tin roofs require soldering or patching when in need of repairs. Temporary repairs may be made by the use of tested elastic bituminous compounds while leaks of a minor nature can be checked for a time by the application of a heavy coat of paint. Tin roofs should be painted with a good mineral paint about every four years.

There are many brands of composition roofings, commonly termed prepared roofings, which are laid in sheets or from rolls. Some of these will last from 10 to 15 years, while some of the cheaper grades depend on an occasional coating of some special preparation in paint form to prolong their life. Such roofs can be patched successfully, this being about the only manner in which repairs can be made. The seams and joints have to be watched and may require a little cement or renailing occasionally as this is where leaks are liable to appear first, especially if the laps were not properly secured when the roofing was applied originally. Roofs of this character must receive proper attention, for if a preparation of any kind is necessary to prolong their life it must be applied at the right time.

The last few years have seen the introduction of the asphalt shingles. No development in the field of roofing has come so rapidly as this. The result is a great variety of products of various degrees of merit from many different manufacturers. The asphalt shingle is simply prepared roofing of medium weight with mineral facing. When laid on suitable inclines to shed water it rarely leaks because there are always two and sometimes three thicknesses of roofing material. Shingles from uncertain sources are uncertain in color, but this is not a reason for replacing them. No method of restoring the color of discolored shingles has been developed. Sometimes shingles curl at the lower corners. It is difficult to replace them so the usual treatment in such cases is to nail the corners down with 1-in. fine wire nails.

There are all sorts of gravel roofs; many of them have been bought too cheaply. A three-ply roof made of light felt, put together with 60 lbs. of pitch and tar, and covered with possibly 100 lbs. of gravel, will need repairs inside of three years. A five-ply roof made of 70 lbs. of felt and 100 lbs. of pitch, properly graveled in will last seven years. The addition of 25 lbs. of pitch at the time the roof is built, will make it last from 10 to 15 years. A roof containing about 80 lbs. of felt and 150 to 250 lbs. of pitch, depending upon whether the roof deck is of wood or concrete (as recommended in the Barrett specification), will surely outlast its 20-year guarantee, and probably be good for 35 or 40 years.

Good gravel roofs are made of coal-tar pitch which has a melting point of about 145 deg. F. Roofs all over the country are subject to a temperature of from 130 deg. F. to 150 deg. F. every summer. Under such temperatures these coal-tar pitch roofs automatically heal any small checks that may have developed in the surface during the intense cold of the previous winter. One function of the gravel is to protect the pitch against the blazing heat of the sun. If any bare spots develop in a gravel roof, because of the use of inferior pitch, the substitution of tar for pitch, or failure to apply enough gravel in the first place, such spots should be covered with more pitch, and an ample amount of gravel embedded in it while hot. Many roof failures can thus be forestalled.

Standard gravel roofs or makeshift gravel roofs (hereinbefore described) can profitably be recoated at any time before the felt becomes

exposed and begins to turn brown. The method is to sweep up all roof gravel with a stiff brush, pour on an ample amount of coal-tar pitch, and then resurface with clean gravel. It is safe to use the old gravel if it is screened, but a considerable amount of new material must be added to the old in order to secure a good job.

If the roof has been neglected until leaks develop, it is necessary to go over it carefully after it is swept up and in all places where cracks or serious rotting of the felt is found, such places should be covered with at least three thicknesses of felt and pitch, leaving margins in successive layers of the repair of at least four inches all around before the recoating is done. Most roof troubles develop angles where the roofs join walls, scuttles, skylights, etc. Two or three layers of solidly-mopped pitch and felt in such places never do any harm, and assist in making a good job.

About the only way to repair clay tile roofs is to replace the broken tile with new material of the same kind. When such roofs are constructed originally a number of the tile should be laid aside for repairs, especially if the material is of an odd design and not readily obtained in the market. The repair of tile roofs requires skilled labor.

Large pre-cast cement tile are coming into use, being applied to steel frames for inclined roofs. Few roof foundations are rigid. This permits some movement in the nature of torsion. For this reason leaks develop in the seams at right angles to the ridge and the use of flexible bituminous cements is becoming general for these seams. Such cement is readily applied with a pointing trowel or putty knife, but transverse fractures caused by freezing water are rarely cured by this treatment. Such tiles must be replaced with new ones.

A number of roofs have been laid in recent years with hard shingles made from a composition of asbestos, cement, etc., more nearly resembling slate in size and degree of hardness. In case of failure they must necessarily be replaced with new material of the same kind, if second-hand pieces are not available. These shingles have not been in use long enough to determine their lasting qualities.

Slate roofs are usually repaired by substituting new slate and this can be done readily because standard sizes are always available. A good slate roof having greater than half pitch will last many years without repairs. Slate is not adapted for roofs having less than one-half or one-third pitch, especially in northern climates as the water from driving storms and melting snows gets under the shingles and, if freezing occurs under such conditions, they become broken in great numbers. Where such conditions exist some roads cover the laps and seams with one or the other of the various elastic gums or bituminous cements containing asbestos fibre and weather-proofing oils which are coming into extensive use. This prevents further breakage and makes the roof tight. The cost of such repairs is $4 to $5 per 100 sq. ft., and should prolong the life of old slate roofs from 8 to 10 years. Elastic gums of this nature should be a permanent part of the equipment carried by every repair crew.

M. J. Flynn,
C. A. Lichty,
W. F. Meyers,
Committee.

DISCUSSION

(Inspection and Repairs of Roofs)

The Chairman:—You have all had more or less trouble with roofs and undoubtedly many of you have ideas about how roofs should be maintained.

J. S. Robinson:—In the inspection of roofs, especially of large shops, great care should be exercised to ascertain the cause of leaks. I was called on by one of our foremen to examine a bad leak in a slate roof. The building had been built some time before and we had never had any trouble with it before. I went through it with him and he showed me where an air lift was attached to the members of the truss, which were light. I examined the particular place where he said the leaks existed, at a time when no trucks were being lifted by air and again when they were lifting heavy freight trucks with the air lift. I found that this lifting pulled the trusses so that the roof leaked very badly.

As to shingles, we have both asbestos and asphalt roofs, and so far they are giving good success. We have more of the asphalt than we have of the asbestos.

The Secretary:—Mr. Myers furnished us with the information in the last part of the report which was drawn from his experience in using plastic cement. He had some slate roofs that were very poor and, failing to secure an appropriation to replace them within a reasonable time, he used some of this cement, troweling on a thin coating, and it left the roof in better shape than it was before. That cement has been on three or four years, and the roofs are still in very good condition. He thinks they will last five, six or seven years longer since they have received this treatment.

J. S. Robinson:—I have had a similar experience. I had a building for making carbide in, on which a prepared roof had been specified. It leaked and we covered it with an asbestos gum which has proven very satisfactory. It made a very neat roof and stopped the leaks so that we have had no further trouble with it.

P. J. O'Neill:—How was this applied to the roof?

The Secretary:—It was put on over the roof in a very thin layer so that it would get under the lower edge of the shingles and into every interstice. I don't know that it would be absolutely necessary to cover the flat surface of the slate, except to keep it in one continuous mass. It was put on about as thin as it could be put on, and probably it was easier to cover the entire surface. It made a very nice job, and has given very good satisfaction. I suppose that if this cement were troweled under the laps, in vertical and horizontal joints, it would answer the same

purpose but it would take considerably more time to do that, and probably be more expensive.

W. M. Camp:—How is the cement applied?

The Secretary:—It is applied, I think, with a trowel.

J. S. Robinson:—We put it on with a trowel, about a quarter inch thick.

P. J. O'Neill:—We apply it with a trowel, and we have also applied it with a brush. It seems to me that a great deal of work is expended in so placing the cement that no back water can penetrate under the bottom of the slate. I can't conceive of a slate roof getting in such a condition that you would have to plaster the whole roof with cement.

J. H. Markley:—I placed a coating about ⅛-in. thick of a material called "Sel-mar-sel," over a roof about four years ago. It has stood the test of four winters, and is apparently as good as the day it was put on. We had similar trouble with gutters on the road, and we have used the same process. We had cases of galvanized iron gutters which had begun to leak and rust out at the joints. We plastered a little of that material over them with a brush, then laid on a piece of heavy canvas, and plastered again over the top of that. Some of these repairs have been on four or five years. I also use the same process on gravel roofs.

The Secretary:—Is that in the nature of a plastic compound?

J. H. Markley:—The same thing, but with a different name.

G. W. Andrews:—One thing many of us are prone to overlook is that, if we want a good roofing, we must expect to pay a price for it. Some of us are bound down by rules of purchasing departments that force us to accept as a substitute for what we know is a good thing, a material that is cheap, the cheapness being its only qualification. Take the prepared roofings as an instance. There are prepared roofings on the market that we can easily get ten years' service out of. I have known of instances where we got 17 years' service from prepared roofing without the application of paint, and it covered a large surface, too. I have known of other cases where prepared roofing was bought by the purchasing agent with the statement that "this was offered by a reputable manufacturer under a 10-year guarantee, without the application of paint," which we were forced to accept on account of the price, but at the end of 7 years the life of the roofing was gone absolutely, and that was as long as the company lasted that furnished it. Therefore, the guarantee

was of no value. I say that in this particular line of roofing we should insist on high grade materials from a reputable manufacturer, whose guarantee is of some value. Unless we do that, we will be badly fooled. Most of us know that a metal roof is about the most uncertain roof that we can put on a railroad building. We have a great many of them, put on in previous years. Some of them have been on a good many years. They have been painted probably once a year, which is unusual for railroad buildings. But in late years we have been using on the metal roofs plastic cements of almost every type made in this country, and our experience with them as a whole has not been good. It stopped the leaks—stopped them absolutely—for 18 months to two years. Then when an examination was made with a view of applying more plastic cement, we found that it had eaten the metal, at least perforated it. We could pick it off with our fingers and crumble it like one would a crust of bread. I have come to the conclusion that for a permanent building with a pitch sufficient to hold the gravel or slag in place, the high grade, built-up coal tar or asphalt roof is the only one that is of any value. Of course we feel very often that slate is everlasting, but the nails with which we apply the slate are not everlasting. We have used the copper nails, wrought iron nails, steel nails, and none of them are everlasting. When the nail gives way the slate gradually falls out of place, and very often it breaks in falling. That means new slate to go in, and it means that you have to put the replacement slate in with a nail that is exposed. You can't get it under the slate above it; you have to put it close up to the edge. The result is that you have there a small leak which ultimately cuts out that nail. Of course, for roofs on heavy pitch the built-up roof is out of the question, because the slag that you put on the felt will not hold, but runs off; but for a light roof such as for a roundhouse or shop, where we can make it sufficiently light, I heartily recommend the built-up roofing. For temporary buildings I would never think of putting anything on but the prepared roofing, getting it on a 10-year guarantee, so it will be useful for any building that we want, for one year or for 10 years. We know, of course, that the most of our temporary buildings ultimately turn out to be permanent. With a 10-year guarantee we will get the full value of the roofing in the ready prepared type. With the built-up roofing on the small pitch, we will get a roofing that will last in-

definitely. I can recall a roofing that I put on a building in Philadelphia in the summer of 1886, and 26 years afterwards when we tore that building down the original roofing was still on and still intact. It was a built-up roofing. All of our roundhouse buildings are now covered with that type of roofing. The resultant effects have shown that we were justified in using that type. We have, of course, a large number of slate and tile roofs, and as far as the material in itself is concerned, no objections can be raised, except as I have already stated, that we must get a nail that will hold that roofing in place before we can call it one of exceptionally long life.

C. J. Scribner:—We have used plastic cement for repairs with very good results. One of our large depots needed repairs to the gutters three years ago, and this cement was used, with canvas or muslin to hold it together. While we have made no inspection of this roof, we have heard no complaint about it from the division people, and that is a pretty good indication that the roof is all right today. That expedient saved us several hundred dollars in that particular case. As I understand it, this roof, if used as an entire roofing, is very expensive, but it is claimed for it that it is of very long life. One of the principal features claimed for this cement is that it will adhere to almost any surface. You can apply it to a tin roof, a wooden roof or a slate roof; also it is claimed that it will stick to that material even though the surface may be wet, so that the proverbial old man might go out and repair his roof even in a storm.

Another feature of this material is that it is always plastic. This feature led us to apply it to a water tank that leaked. There was a layer of concrete in this water tank and as the staves rotted and gave way from the concrete, the leak developed beside the concrete. We drained the water from this tank, cleaned out the mud, applied a coating of this plastic cement and then a coating of muslin, and then more cement, with a result that about 70 per cent of the leakage of that tank was stopped, and the life of the tank was prolonged and its renewal delayed for about two years.

G. W. Rear:—Mr. Andrews is correct about the roofing business. Everyone knows that the purchasing department forces things on us that are really not of the best. It will continue to force them on us and we must make the best of it. Nevertheless, those that have charge of the specifying of roofs

can at least specify the right thing, even if they don't always get it. I think Mr. Andrews is right in that a roof put up after a certain standard specification, will give service far beyond any ordinary guarantee. Incidentally, I don't think a guarantee is worth very much, because if a roof is guaranteed for 10 years, and it goes 9, either the people that you bought it from are not in business, or they can find some reason why the roof gave out.

Regarding the slate roof, slate, of course, is permanent, but it has many enemies outside of the nails. I remember one rather beautiful station which we were somewhat proud of, with a slate roof on it. We received a message one time that the roof was in a very bad condition. The building had then been up for about 15 years. It was a wonder to everybody that the roof should have gotten in such a terrible condition so suddenly. I happened to be in that neighborhood, and I made a little investigation of my own. I found that the telegraph men had strung about 15 wires lengthwise of the building overhead, and in taking up the slack they let the wires drag over the roof; each wire took off a lot of the slate. We also find that slate roofs are ruined by people walking around on them. Even if we could get a nail that would last forever, it is doubtful if a slate roof could be maintained forever.

Regarding this plastic cement; some people are putting it on with a kind of a grease gun. Somebody may know something about that particular method of application.

G. W. Andrews:—I am willing to agree with Mr. Scribner that cement applied as he states may be a good thing. I don't doubt but that it is. My remarks covered the application of the cement on raw metal, and not on a muslin or canvas under-coating. If we put a coating of this cement on the raw metal and cover that with a coating of canvas or muslin, we protect it to a certain extent from the weather. Then we put a coating of cement on the muslin or canvas, which protects it. No doubt in a case of that kind we would get much better results, but the statement that I made, and which I still make, was that the cement had a deleterious effect on the raw metal, and that while it stopped the leaks for a short period, the ultimate result was not good.

The Secretary:—That might not be the case with all brands of cement. Some of these compounds do not have a bad effect on metal roofs.

E. K. Barrett:—I would like to cite a case from my experience. I have many galvanized iron roofs and up to about 10 years ago it was very hard to get anything to stick to them. About ten years ago I had a warehouse roof of galvanized iron that was pretty full of holes. At that time we were hard up for money, and I got a contractor to agree to put on a roofing cement, and guarantee to save me that roof for three years. He put on the preparation and it carried the roof for seven years, at the end of which time it commenced to leak a little again. I went over it and decided it was in good enough shape to treat again, so I went over that roof with another coat of this material, and it is still giving good results today. I contracted that coating for $1.65 a square, as I remember it, 10 years ago. You buy it by the barrel and apply it with a brush.

C. J. Scribner:—I might say that the use of canvas or muslin is not intended, as I understand it, to be in any way a protection, but this plastic cement always remains plastic, and if the opening is very large, the cement will draw through it. The canvas or muslin is to prevent that—to hold the cement in place.

A. Ridgway:—I should like to ask the committee if it gave any attention to the repair of concrete roofs?

The Secretary:—Evidently not, from the report.

E. K. Barrett:—I had to put a concrete roof on a vault building about four years ago, and about three months after I put it on the trouble started. I tried several things on it without success, until I bought some asphalt and went over the whole roof with three heavy coats. Since which time I have had no trouble.

F. C. Baluss:—I have had experience with concrete roofs on a slope of about 1 in. in 12. When the roof was new I applied a coating of cement and after five years we have had no trouble. I have renewed the protection with the same cement again as it has been very satisfactory, and it is very cheap.

C. Ettinger:—Mr. Andrews is right in stating that he had trouble with plastic cement where the compound had eaten through iron or tin. But I believe I can give a reason for it. We should ascertain whether these plastic cements and plastic compounds contain coal tar, especially in the crude form. If they do they are bound to attack metal. You will find the plastic cement compounds of good quality can be bought by the purchasing department, but they will not pay the higher price. Some of the compounds with sulphuric oxide as a base, with the addition of a

pure gum, will stay on copper, to my personal knowledge, for five years, on a longitudinal joint. We know that copper contracts and expands just the same as iron and steel does. I put some cement for a trial, on a joint on a copper cornice, and it remained there for five years before it commenced to tear. It is a question of the right compound more than anything else. We have tried the muslin protection on our road. We apply a coating of this cement in the consistency of heavy cream, then we lay a layer of light muslin, and on top of that we mop some more of this paint. We have carried roofs over in this way for five years, but they were gone after five years. You could tear the muslin just like rotten paper. But it is a good thing on buildings that you must carry over and which it is intended, perhaps, to replace in the near future. You can do that at present prices at about $6 a square. When we started out 6 or 7 years ago I did it as low as $2.50 a square.

L. Spalding:—I have had a good deal of experience with leaks in concrete roofs. We have several concrete buildings among our shops, one of which is a store house with a plain concrete roof over it. This building was built six years ago, and, after the first year, we had trouble with leaks, due to contraction and expansion. Pitch was applied at that time, but did not prove satisfactory. Four years ago we removed the pitch and used plastic cement in the cracks, since which time we have had no trouble. We also had a roundhouse with a concrete roof covered with gunite, put on with a cement gun, that has caused a good deal of trouble in the past few years, due to the very fine cracks developing in the gunite, allowing the water to go through. I happened to get up on that roof on a hot day last summer. I went over it with a magnifying glass one day to see if I could find any cracks. I could not find them but by turning the hose on a small portion of the roof with the hot sun on it, and allowing the water to evaporate, the fine cracks showed up very quickly as the water in the cracks did not evaporate as quickly as on the flat surface of the roof.

METHODS AND EQUIPMENT USED IN RENEWING TIMBER BRIDGES IN WHOLE AND IN PART

Committee Report

Railroad timber bridges are as old as railroading. The art of building them has been well developed for many years and, as their construction is quite simple, new features are not frequently brought out. As timber has become harder to obtain, traffic heavier, and the country drained, more permanent types of bridges have been constructed, or the openings filled and abandoned. On many roads an untreated timber bridge is now built only as an emergency structure. Improvements in methods in recent years have been confined largely to tools. These are mentioned elsewhere. As a consequence of these conditions this report is largely a résumé of present practice.

Repairing Timber Bridges

In general, gangs for timber bridge work consist of a foreman, an assistant foreman, and six or eight men as follows: two first class carpenters, two assistant carpenters and two to four laborers. Variations from the above are made as the work demands or in accordance with the kind of men available.

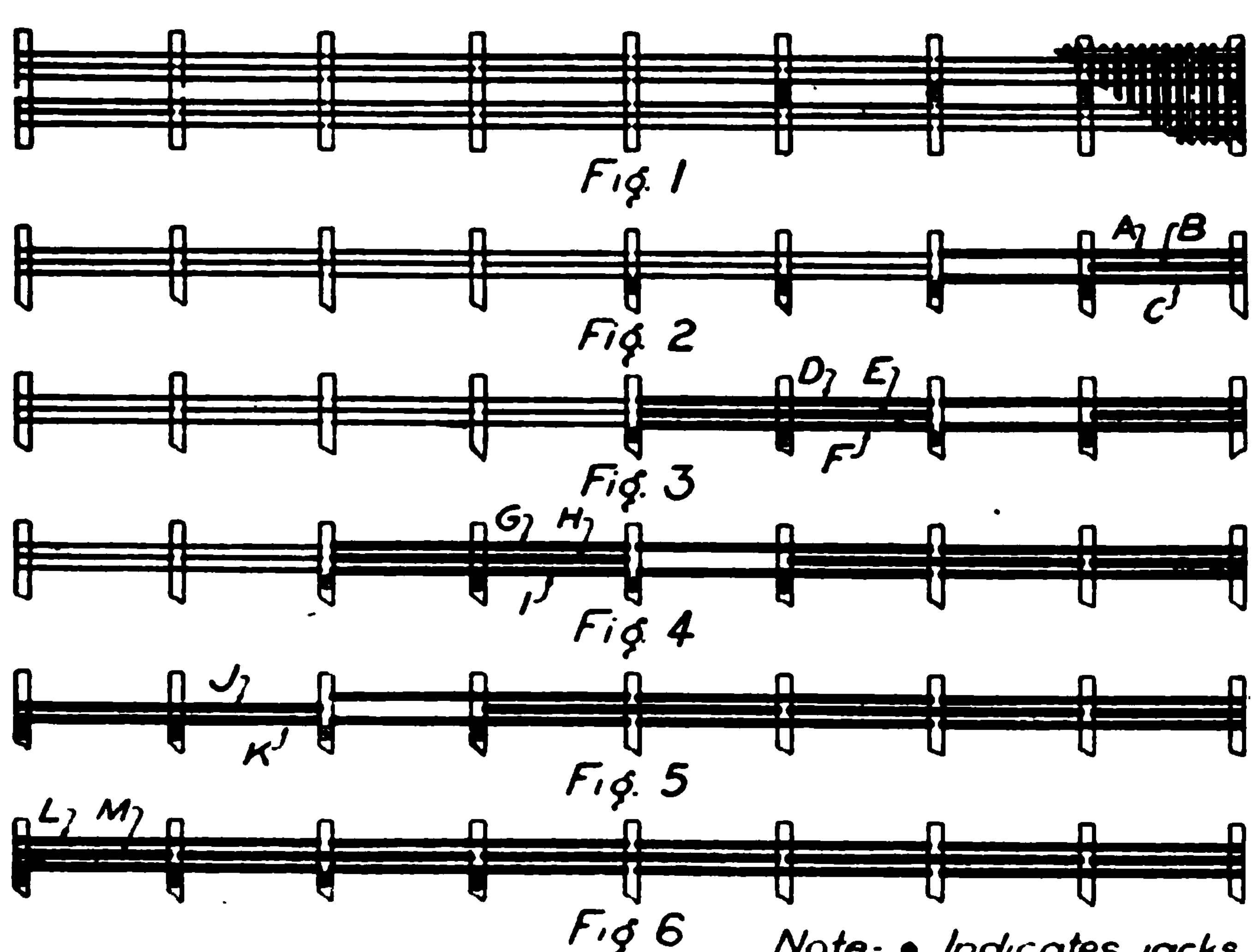


Fig. 1, Fig. 2, Fig. 3, Fig. 4, Fig. 5, Fig 6

Note: • Indicates jacks

The distribution of material depends on the quantity to be handled and traffic conditions. Where material is ordered from the mill, cars may be consigned to the station nearest the bridge site for unloading or redistribution by one of the methods mentioned below. When shipped from the storehouse, the use of company service cars may be found convenient. These can be held under load and shipped from point to point as the work progresses. For unloading use may be made of a special work train or, where the quantity of material does not justify

this expense, recourse may be had to a local freight train. When two or more cars are to be unloaded it may sometimes be found economical to distribute the unloading by local freight train over several days. Small quantities are handled by motor trailer or push car.

There does not seem to be uniformity of practice in the use of second hand material in any given part of the bridge. It would appear to be the best policy to use second hand material only for blocking and helpers on important lines, but it might be used somewhat more generally on light traffic lines in bridges, the life of which will not be greater than the life of the material.

Where one-third or less of the piles in a bent are in bad shape satisfactory repairs can usually be made by cutting off in solid material at or below the ground line, and setting in a post on this foundation. Such a post will have a better appearance if it is of the same shape as adjacent piles. It should be spliced to the foundation pile with four three-inch scabs bolted through, drifted through the cap at the top and well bolted to the bracing. It should have an identifying mark as a helper. Posts are sometimes put in on blocking between piles. A weak pile may thus be relieved of some of its load and at the same time the benefit of its stiffness be retained. A repair of this kind is an obstruction, if placed in a stream, and is unsightly in any situation. In cases of settlement or where piles are decayed far below the ground line, it may be necessary to drive a new pile along side the old one and spring it under the cap. When entire bents are to be removed, in most cases, the pile may be cut off at sound timber below the ground line and a frame bent erected on this solid foundation. The bent should be framed without a cap, set up and made ready to slip in as soon as the

Note.

Thoroughly tamp the ground around all new work

In replacing with posts, dig down until sound timber is found and in no case less than 4'0" below the surface of the ground, except where water prevents.

In replacing with frame bents, dig down until sound timber is found.

piles are cut off. When conditions require it an entire new bent may be driven along side the old bent, the new piles sawed off, the old piles cut out and the new bent pulled into place. Some roads restrict the height at which frame bents shall be used in this manner to ten feet.

In renewing caps it is first necessary to pull the stringer drift bolts to clear the cap. Then jack up the deck one or two inches, (jacks may be supported on the ground or on sash timbers bolted to the piles for the purpose), raise the old cap to give room to cut off the drift bolts with a hack saw. When this is done, roll off the cap. The new cap

having previously been framed and a hand line attached about its center, let it down over the side of the deck and swing it into place. Drift it to the piles, lower the deck and redrive the stringer drift bolts. When a scaffold is necessary for this work it may be hung from the ties with staging hooks carried regularly in the outfit for this purpose. An old cap may also be removed readily by cutting it into three or four pieces and splitting it out. This gives easy access to the drift bolts in the tops of the piles.

The renewal of an outside stringer is quite simple as it is only necessary to withdraw the bolts, jack up the rail and ties about two inches, turn down the stringer to be removed, shove it out on the caps, drop the new stringer previously framed on to the caps and raise it up and bolt it. To renew the middle stringer in a chord the method is similar but with broken joints it is necessary to remove the bolts extending over four panels. After raising the track, the two outside stringers are laid down, the weak center stringer removed, the new one placed and the balance of the chord reassembled. When it is necessary to renew an inside stringer it may be done in single panel lengths from the inside as described above, the new stringer being handled with lines through the deck. In renewing an inside stringer extending over two panels, it is necessary to take up the guard rail and shift the ties, either along the track or to one side. It is then possible to drop the new stringer vertically into place. This method may also be followed with center stringers. Some prefer to raise the track a little more than the width of the stringer, roll the old stringer over to its side and raise it and work it over the chord and on to the caps. The new stringer is placed by reversing this operation.

A method of strengthening the chord involving much less labor consists in adding an additional stringer on either side of the existing chord. It is not, however, good practice to leave partly decayed timber in a bridge because of the fire risk.

In renewing isolated ties, remove the adjacent deck bolts and pick up the track about six inches. Place a 4 in. by 4 in. stick about 10 ft. long across the stringers on each side of the tie. These may be held in place by wedging under the rail or other means and should project on the side toward which the tie is to be moved. Rollers are slipped under the tie and it is rolled out until it clears the rail, when it can be lifted up on to the track and disposed of. Where a number of ties are to be renewed, put in all the new ties in one place and spot in the good second hand ties where needed. In such cases it is usually necessary to take up the guard timbers where the new ties are put in. Another method is to raise one rail higher than the other, slip the ties out to clear the low rail and then back and over the low rail.

It is usual to lay guard timbers in position and mark the location of the ties. The daps are then cut in them, either on the bridge or the bank and the timber placed in final position. It is the practice of one road reporting to this committee, where more than 50 ft. of guard timber is to be replaced, to measure the tie spacing on the bridge and dap the timbers in the shop.

Renewing Timber Bridges

The year's program for timber bridge work having been determined, it is usual to do all the driving in advance and let the pile driver crew return later to place the timber, or have this work handled by other crews. A minimum of pile driver and work train service is thus secured. After locating the bents to the best advantage relative to the waterway and clear of existing bents, and marking their location on the rail, the guard timbers are taken up, the ties are shifted to clear the new bents and driving is started. It is usual to work backward on a bridge. The work will proceed more rapidly if piles are distributed on the ground in advance. After driving the piles, the ties are respaced as well as is

possible and guard timbers are relaid, cutting out the spacers where necessary.

When the bridge crew arrives at a bridge where the piles have been driven as above, the first step is to straighten and line up the piles. This may be done with jacks and steamboat ratchets and the piles should be held in position. If badly out of line this work should be done with the pile driver before it is moved from the job. After marking the grade, usually obtainable from the track, and attaching a guide board the piles are cut off. The stringers and deck are then raised about two inches on the old caps to permit the placing of new caps. The cap is brought in, swung off the deck on to the top of the piles and drifted in place. Sway bracing is next put on and bolted up. With high bents, say over 20 ft., some longitudinal bracing should be put on as the stringers are placed.

As soon as two or more caps are in place measurements for the length of the stringers are obtained and the framing of stringers can be started. This should be done on a level stretch of ground as near the bridge as possible and consists in cutting to length, sizing to depth over the caps, and boring for drift bolts where they are used. Holes may also be bored through one line of stringers in each chord for packing bolts.

Methods of assembling stringers into chords are varied. In most cases one chord is changed out completely before the other one is disturbed. Information in regard to the methods described below was furnished by E. M. Grime, supervisor of bridges and buildings of the Northern Pacific at Dilworth, Minnesota, and applies to chords with three stringers. All bolts are removed from the old chords and the deck is raised about one inch. One of the old chords is then shifted a few inches toward the center of the bridge and the stringers of one new chord assembled in order on the ends of the caps in the space so provided. Stringers of both old and new chords are then shifted in toward the farther old chord, permitting the second new chord to be assembled in like manner on the caps. Then with all four chords on the caps, they are gradually crowded over in the same direction, one stringer at a time, until the old stringers can be lifted off the caps at the farther side and the new stringers reach their correct position in the bridge where they are bolted together and fastened to the caps. While this method is somewhat slow it commends itself because the work can be carried on with a crew of six men and with no delay to traffic other than a five or ten mile slow order over the bridge.

In the second method described by Mr. Grime, the bolts are removed from one chord and the center stringers of this chord are cut in two so that they may be removed two panel lengths at a time. Beginning at the end, the bridge is raised on one side over four panels on jacks placed on the caps. Two panels of the old chord are then taken out and two new panels, omitting the center stringer in the second panel, are put in. Three full length stringers are next placed in panels three and four and the center one slipped back to panel two and three. Jacks are then moved forward and this method is followed across the bridge until the end two panels are reached, when the inside and center stringers are placed, the latter slipped back one panel and the additional center and outside stringer placed. Bolting and bracing can follow along as fast as the stringers are in position. Following this method the work can be well handled by a crew consisting of a foreman and six men. It is necessary for the foreman to keep in close touch with the dispatcher and for this purpose a portable telephone is a great convenience. It should also be noted that one-third of the old stringers are cut into two pieces.

The method of renewing individual ties has been described. In renewing a bridge, when the old ties are in bad shape about one half the new ties are put in between the old ones before placing the string-

ers. This gives a more substantial deck to work from. The remainder of the new ties are put on after the stringers are changed. Ordinarily ties are put in between the old ties or in groups as traffic permits, after the new stringers are in. Some roads defer this work until all the heavy timber released is picked up to avoid scarring up the new deck. With the placing of guard rails the bridge is completed.

Released material of no value is ordinarily burned at the site, or disposed of for firewood, but good material should be loaded with a derrick car and shipped to division store yards for further use. In the last few years a number of railroads have been cutting released bridge timbers into dimension materials for use in building work. Such material is seasoned and is frequently of better quality than new timber.

Every bridge gang should have a sufficient supply of the ordinary tools of good quality. Where special tools have been tried out and proven advantageous, gangs should be supplied with them. There can be no argument about the desirability of labor saving devices at the present time, not only as a means for reducing the amount of labor but for keeping the men employed better satisfied. Among such agencies first place should be given to the motor car and its trailer for handling small amounts of material. Ball bearing jacks, patent bushed blocks and thin-backed saws are some of the devices that lighten labor and shorten the time for doing the work. A hand winch or crab mounted on an "A" frame or gin pole or a push car, is almost a necessity in every outfit. Devices of this kind are described in the Proceedings for 1918.

Maro Johnson.
E. K. Barrett.
E. E. Clothier.
F. N. Graham.
A. J. James.
J. P. Wood.

DISCUSSION

(Renewing Timber Bridges)

The President:—Gentlemen, this is a good report on a subject that everyone of us is vitally interested in. It seems to me that this ought to call for active discussion.

E. K. Barrett:—The report mentions the jacking up of stringers by bolting on side braces. I get away from that by using a 2-in.x2-in. extension clamp which leaves it 12 in. in the clear, and the horns drop down and catch under the outside stringer. The saddle catches over the foot lift of the jack, so I don't have to bolt on any sash braces. I simply roll the jack into place and it will pick the stringers up without bolting on side braces.

G. W. Rear:—My understanding of this idea in trying to get the cap out was to jack up the weight so as to get it off the cap. The only objection I have is to the driving of piles under a trestle without the stringers having been shifted so that the piles are driven in their proper place. I don't believe that a good job can

be done by trying to drive the piles unless the stringers have been shifted so as to get the pile started where it is intended to be, and driving it where it is intended to stay—either with a 3-ply or a 4-ply chord. We have never yet been able to find a way of doing a good job without shifting the stringers, especially on the lower trestles. It may be that when the trestle is of considerable height that the piles can be spotted in without springing them too much out of the way. We find in our practice that the best way is to go to the bridge with a pile driver and finish up the job before you leave it. The first thing to do is to shift the stringers and make a place for the piles to go. When you do that, and the trestle is finished, it will stay in line. It may be that the experience of some people may prove that they can be sprung in place satisfactorily, but we hardly believe that it is the right thing to do.

E. K. Barrett:—I notice that the report says to "Lay your guard rail on," etc. Our guard rails are all standard, and if one is removed it will fit somewhere else. In putting in ties it is our custom to take out the full number that we have new ones to replace and put them all in together, and then spot in the old ones at intervals where we can use them.

J. J. Taylor:—Referring to the remarks about strengthening bents by driving additional piling, I have had a good deal of experience with that, and do a great deal of it. I agree with the thought that to drive the pile on the side and jack it under gives poor results. Our plan is to jack up the chord, shift the cap endwise, and drive the pile exactly where it belongs, saw it off, shift the cap back the other way and drive the pile on the other side. In that way you get the pile standing normally, where it is trained to go, and get much better satisfaction. It can be done with a pile driver crew very readily while they are there.

G. W. Rear:—With regard to the renewing of the ties, I think that circumstances govern cases. We often find that joint ties under the rails are gone long before the others, especially with continuous joints. We renew them many times when no other ties on the bridge or trestle are renewed. We find on long trestles a tie here and there that should come out, and we renew those particular ties. I don't think that it can be said that it is good practice in all cases to renew all the ties together in one place and stick the second-hand ties in here and there. I think

there is room for the display of a considerable amount of judgment there.

J. P. Wood:—Ordinarily such ties will go over until several can be taken out within a short distance. It has been our practice not to renew any ties unless they are damaged by fire or are extremely bad, until we can renew 15, 20 or 40 at one place, as this saves a considerable amount of time and labor. It has been demonstrated by my experience that if you have only one or two bad ties in a place, they will ordinarily carry. You may have to dap out and insert some ties of hardwood timber. They will carry you over until you get time to put in others.

A Member:—I don't agree with Mr. Wood, for the reason that if you are going to let ties go until you can renew 25 or 30, you are liable to let it go until there are 40 or 50. I believe that the ties should be looked over every year and those that are to be renewed or repaired should be taken out. I don't agree that it pays to take a number of ties out in one place and then jack up the track and scatter them through some place else. I believe that a tie that will go over a year ought to be left in the place where it is, and the next tie to it, if bad should be replaced.

G. W. Rear:—We use a standard tie, dressed in the mill to 7¾-in. by 7¾-in. Every tie we put in is of that same size and no sizing is done after that. A ship spike is driven through the guard timber into the tie. When we go to renew the tie we pull this spike out, nip the rail up a little and slip in a new tie.

E. K. Barrett:—There are many different ways of putting on a guard rail. With us the guard rail is bolted to every fifth tie, and the other four ties are not fastened to it in any way. I prefer to put the ties in in a bunch to avoid putting a full size tie beside one that is rail cut. When I have 30 or 40 ties to put in a bridge, I place them all together, for the simple reason that it leaves the rail supported on ties of the same height; not with two or three full size ties spotted in with two or three ties that are rail cut.

P. N. Watson:—We frame such ties as are necessary for the structure to the right size in the shop and ship the ties to the bridge. We then lift the rail with a hoisting engine, block it and slip in such ties as are necessary, then drop it down and go to the next place. We don't bunch our ties, because of the fact that many of the old ties that come out may last longer than the new

ties we put in. We find that plan much more satisfactory than to put in all new ties and place the old ties elsewhere.

A. S. Markley:—I fully agree with what Mr. Barrett says, that new ties should be put in all together, because the old ties are rail worn. The use of old ties in the track is a serious proposition in case you have derailment. Recently we had a 250 or 300-ft. viaduct on which loaded cars carrying 140,000 lbs. derailed, damaging the ties so that it was necessary to remove them. We took those ties out, cut them off to 9 ft. and used them again.

G. W. Rear:—Unfortunately I can't gain an idea from this argument as to what is to be done with those bad ties under the joints. Naturally no ties will be renewed unless they need renewal. If you have two or three ties here and there for a distance of ½ mile across a trestle, and you count them up and there are 100, and you then say that you will put in 100 new ones here, and take the old ones and put them in some other place; I don't see that anything is gained. The chances are that you could find enough second hand ties around the road to do this work without taking them from that particular trestle. In extremely bad places, where the ties have got to come out, they could be replaced with second hand ties or new ones. We have no rail cut ties because we use substantial tie plates on each tie and as we have about three times as many ties on a trestle as on the bank, the ties on the trestle don't cut. Where you have no second hand ties in good condition, new ties ought to be placed where they are needed. Modern methods of putting them in make it a comparatively simple job, and I venture to say that six men will put in 75 per day.

E. K. Barrett:—What about the fellow that has no tie plates? I can show you plenty of ties on my bridges that are cut three-quarters of an inch deep. If we take out one hundred ties and put in one hundred new ones, we then scrap the ties that are no good and use the others under the joints you are talking about.

A. S. Markley:—I can't see the advantage of transferring the old material to another bridge. You can cut down the old ties under the continuous joints.

J. L. Pickles:—We get around the rail cutting by taking the guard rail off, putting the new ties in promiscuously, and turning the old ties over.

A. S. Markley:—Where you put in new ties continuously you know that it is not necessary to disturb that part of the bridge again until those ties are worn out, while if you are spotting ties continuously you have to keep disturbing it.

F. C. Baluss:—There is another point to be considered—the cost of labor. If you take out enough poor ties and bunch those together and replace them with new, all in one place, you are going to spend more money doing that than it would take to buy tie plates. We find, and I think you all do, that labor is as hard to get as material, if not more so. The matter of cost must be considered in these matters.

The Chairman:—There ought to be some discussion on the method of renewing stringers.

M. M. Carmody:—I don't quite agree with the committee report in the suggestion that the third chord be cut in two in order to remove it. I think this is a mistaken idea, and a very expensive one. I have had 22 years' experience in that line. We used to cut the third chord, but I find the only remedy in renewing the chord is to shift it back when you get it properly jacked up and free. You have four pinch bars lying on the bridge handy, and an organized force will shift that chord back in a few minutes. Consequently, you have saved 20 to 30 min. in sawing that chord in two. I have an extra chord to drop in to take the weight where one has come out on the outside. I notice that some of those here have said that the ties are cut down three-quarters of an inch. As a rule we clear the deck on the main line and carry the second hand, or best ties, back to the side lines. I don't think it is good policy to patch in ties, when you can take care of your best second hand ties anywhere.

A Member:—It has occurred to me from about 27 years' experience that when we have at least twice as many ties on a bridge as are necessary to carry the load it can be allowed to go, provided the ties are not all in one place, until 50 per cent of them are ready to be renewed. Then all the ties can be taken out and the deck renewed entirely, working the second hand bridge timbers into building lumber, where there is less danger of accident than there is on the bridge. Where too much patching is required with timber bridges it is cheaper to renew the bridge and work the second hand stringers, ties, caps, etc., into building lumber of various sizes, thus keeping the bridge in good surface, line, and safety. I have had the experience where a bridge deck

had been patched so much that it had gotten out of surface and line to such an extent that it was necessary to take all the ties off and re-deck the bridge to get it in surface. I believe there are other members here who will say that the better method of disposing of the second hand bridge timbers is for building material.

G. W. Rear:—We will all agree with the last speaker that 50 per cent of the ties could be permitted to get bad before the deck is renewed, providing the 50 per cent were distributed alternately, one good and one bad one, but suppose that the 50 per cent are all in one spot.

Returning to the renewal of stringers—no two people will agree as to how to change them out. If I was to tell a foreman how he should renew the stringers on the job he was going to start tomorrow, I couldn't tell him how to go at it. He might not have a train from seven o'clock in the morning until six at night or he might have a train every five minutes. He might have only 2 men or he might have 25 men. Those two conditions would require radically different methods. How are you going to establish arbitrary rules with conditions like that?

Mr. Estes:—In changing out caps I have used four jacks, two on each side of the cap to be changed. Our bridges are bolted together. You can lift the cap up and take a chisel bar and cut the bolts off. If you are high in the air you would have to throw in a temporary scaffolding to handle the bolts. You won't have to use any blocks in changing your pile.

Mr. Johnson:—I am interested in the reclamation of relieved lumber as building material. I understand that they do this on the C. & E. I. Perhaps Mr. Markley can tell us something about that.

Mr. Markley:—I don't think there is anything in it. (Laughter.) With second class material, and ties in particular—way out in the country—you may have to stop a train to load a few ties on a car. You send the car in to headquarters 100 miles away and get it unloaded. In doing all that you have run up more of a bill than the timber is worth. When we take up the ties we use them for bulkheads and similar purposes, but we never work them over.

INTERNAL COMBUSTION VS. STEAM ENGINES FOR PUMPING WATER

By C. A. Lichty

In the early days of railroads the steam pump had no competitor. It was purely and simply the question as to the type of steam pump and outfit that was best adapted to suit the conditions. Steam was the "old reliable" for so many years when it was the only power considered practical that it has in many cases been difficult to supplant it with the newer type of plant, especially where coal and labor were cheap and where the quality of water was good for steaming purposes, and more especially as long as the plant in use was capable of rendering the service, regardless of economies that might be effected by the installation of a more modern plant and apparatus.

Some authorities maintain that the larger and more important pumping stations can be operated most successfully by steam, while others are substituting internal combustion engines, even in the immediate vicinity of the coal fields. Many, especially on the northern roads, maintain steam plants, making use of the exhaust steam by running it into the water to keep it from freezing in the tank; besides, when the pump is not in service live steam can be used for the same purpose, as well as to thaw ice from spouts, valves, etc. In most of the states steam plants are subject to a rigid inspection. For instance, in the state of Illinois, boilers must be inspected and tested four times per year, and the plants operated only by licensed enginemen.

One of the principal reasons for getting away from the steam pumping plant, is on account of frequent renewals of boiler sheets and flues. In some cases boilers have to be changed out in from six months to a year, depending on the nature of the water, necessitating the boilers to go to the shop for repairs. This entails considerable annoyance and expense.

Tests for efficiency as far back as 1882 showed that the gasoline unit was an active competitor with the steam plant for small installations, and about 10 years later it was generally conceded that it had gained the supremacy, but just about that time the rapid development of the multi-cylinder, small type of engine used so extensively for propelling automobiles, trucks, motorcycles, airplanes, etc., created such a demand for gasoline as to give the larger sizes of internal combustion engines a temporary setback until it could be arranged to operate them successfully with kerosene and the cheaper grades of fuel oil, since which time they have again made considerable progress.

The cost of installation of the two types of plants under consideration, of like proportions, may differ but little except for plants ranging from 1 to 10 hp., where the oil equipment would be much less. In fact, for plants of this size steam can scarcely be considered a competitor. In some installations of from 20 to 50 hp. the oil engine may be more expensive than the steam engine and boiler. When the additional space for the housing of the latter and its fuel is taken into consideration, it is doubtful if, in many instances, the steam plant has any advantage in cost.

There is little room for doubt but that the oil engine is much more economical in the matter of attendance. The steam boiler requires nearly an hour to get up steam and almost constant attention thereafter for firing and all of the other necessary requirements, while the oil engine can be started in an instant, and when properly installed and adjusted the attention required is only nominal. It is well known that

many of the smaller pumping stations are successfully operated by agents, baggagemen, sectionmen, etc., when conveniently located, in connection with their other duties, requiring but a small share of their time.

A steam plant necessitates about six times the space for transportation and storage of coal that oil does; besides the latter may be conveniently stored underground, where it is entirely out of the way. For reasons just stated the labor required for the handling of coal and ashes is several times that for oil. Some roads require coal to be delivered to pumping plants in considerable quantities during certain seasons of the year in order to render cars and labor available for other purposes when they are most needed. The result is that the coal is most always stored outside, where it deteriorates to some extent and is liable to be stolen or may catch fire from spontaneous combustion. A leading authority from one of the prominent railroads estimates that the loss of fuel from all sources in connection with a steam plant sometimes runs as high as 40 per cent, while in the case of oil it is very slight.

The Diesel type of oil engine has reached such a stage of economical operation, together with the small amount of space required for engine and fuel as to come into general use for boats and ships and all kinds of stationary plants from 6 to 500 hp. They operate successfully with all of the cheaper grades of oils except those having a decided asphaltic base, and the manufacturers now claim that they will soon be able to operate on such oils as well.

The thermo-dynamic efficiency of the semi-Diesel and true Diesel engines ranges roughly from 20 to 35 per cent. The economy in fuel consumption therefore is large when compared with the consumption for ordinary steam engines when it is recalled that the efficiency of the small 4-valve Corliss engine is about 6 per cent; the Corliss compound 9 per cent, and the triple-expansion engine rarely reaches 18 per cent. It is a well-known fact that the simpler types of steam pumps are the most wasteful.

The cost of the different fuels varies, of course, in the different localities, but there is scarcely any place in this country where oil can not enter into competition with coal for the purpose outlined in this subject, while, on the other hand, in many localities the steam plant can not enter into competition. A concrete instance of the relative merits of the two types is cited in the case of a steam plant in a small town which was recently replaced with a modern type of oil engine for operating a small electric lighting plant, where it is stated that the former cost of operation of 20 cents per kw. has been reduced to 4 cents by the new installation. It is not known whether the total difference was due to the change, but no doubt much of it was. In this particular case both coal and oil were produced within 100 miles of the plant. One of our prominent railroads recently installed an oil engine at a pumping station where steam had been in use many years, and a total saving of fuel and labor has effected a saving of from 30 to 40 per cent. Both types of plants are in such general use and their characteristics so well known that when all of the conditions are taken into consideration it should not be difficult to determine which should be selected for any particular locality.

DISCUSSION

(Internal Combustion versus Steam Engines for Pumping Water)

E. A. Demars:—I consider that a gasoline or an oil burning engine, when installed off the right of way, on a river or a small stream, is more economical than a steam plant, but I consider

that steam is more economical than fuel oil for pumping water on the right of way.

J. Dupree:—It states in the report that in the State of Illinois " boilers must be inspected and tested four times per year." I never found that to be the case, but it is in Indiana, which State has the most rigid laws relating to boilers on railroads of any State in the Union. I am in accord with the last speaker in regard to the relative economy of gasoline and steam engines. I think that a gasoline or an oil engine is the thing to have away from the railroad right of way. We have one pump house a mile from the station and half a mile from the track, at which we use kerosene. At this point we have a kerosene carburetor. We have several others and they give excellent satisfaction. But for a large station, such as at a large terminal, I prefer a steam plant at all times.

J. P. Wood:—I would like to ask the gentleman for his reasons why he thinks steam more economical.

E. A. Demars:—On our road I have found it to be more economical, because it is difficult to get men to operate gasoline engines and keep up the repairs on them, while almost anybody, with slight experience, can handle a steam pumping plant.

C. R. Knowles:—There seems to be some confusion with regard to the question of boiler inspection four times a year. The statement in the paper just read is correct, not only for Illinois and Indiana, but throughout the United States, so far as the United States Railroad Administration is concerned, because their mechanical department circular, No. 11, I believe, calls for an inspection of boilers four times a year. Then, too, in regard to the relative values of the internal combustion engine and the steam engine, I think we may be looking at it from different points of view. One may be inclined to look at it from the standpoint of the cost, and others from the fact that you do not have men to handle the repairs properly; while still others are confusing the lower grade oils with gasoline. When we take exception to the points we ought to state more clearly whether we mean gasoline, kerosene, or low grade fuel oil engines. So far as I am concerned, I use nothing but the low grade distillates, which cost us about eight cents per gallon in tank car lots.

J. P. Wood:—I am of the opinion that, where you have a small pumping station with a drop spout tank where you are not using a great deal of water, the oil engine is more economical

than a steam plant. I call to mind two such stations on my division which are operated by section foremen, with very little trouble. We have two good men there, and it is very seldom that I have to send anyone to make any repairs to either one of those engines. One is a gas engine, and the other is kerosene. But I do believe where you are using a considerable amount of water, and have standpipes, the steam plant perhaps is more economical, taking it from the standpoint that I have to consider, for I pipe the exhaust steam to the frost-box and from that to the standpipe. I have it so arranged that we ean pipe the exhaust steam through there, and live steam too, if necessary. In this way we keep those plants thawed out in extremely cold weather, and escape the trouble of their freezing up through the neglect of some fireman who leaves a valve slightly open so that the water drips out enough so it freezes in time. We had that trouble before I solved it by pumping the steam in there. There are places where the pumping plant is too far away from the tank to do that, but where it is within a reasonable distance this can be done successfully. I believe that in both places, where you can get the live steam or the exhaust steam to the spout and standpipe and keep them thawed out in extremely cold weather, that the steam plant is more economical, for it saves the expense of sending men there from headquarters many times to thaw them out, where you have no plumber who can or will do it.

R. C. Young:—I would like to get the experience of some of the members regarding the use of the vertical type of kerosene and gasoline engines. We have several small ones on which we have installed carburetors and we find that the condensation from the kerosene gets into the lubricating oil and adds to the expense to such an extent that it offsets all the saving there is in the cheaper fuel.

J. L. Pickles:—Referring to the remarks made by Mr. Young, I will say that we have installed quite a number of kerosene carburetors on our gasoline engines and we thought we were making a great saving, but we find that we have to rebore the cylinders in from 3 to 6 months and we are therefore considering very seriously abandoning the carburetors and returning to the use of gasoline. We would do so if it were not that the shrinkage of gasoline is so great.

The Secretary:—There is, of course, a much greater shrinkage in the handling and use of gasoline over that of kerosene.

If the kerosene carburetors are properly applied and adjusted there is no need of reboring of cylinders as often as Mr. Pickles states. We have in use on the Chicago & Northwestern over 100 kerosene carburetors on gasoline engines which are working successfully and I do not find that we have to rebore the cylinders any oftener than when we used gasoline. There is certainly a great saving in the operation of kerosene carburetors on gasoline engines.

C. R. Knowles:—I can't see why we should consider the steam engine simply for the purpose of keeping the penstock free of ice. It seems to me that the question of frostproofing the tanks and penstock pits is more a matter of design. We have penstock pits and frost boxes, etc., throughout Iowa and South Dakota, with which we have very little trouble from freezing. We do have some of them frozen once in a while, but that is merely the result of carelessness. I have some figures on the comparative cost of operation for a steam and oil plant. The figures were collected at a plant which was only recently changed from steam to oil. It is not a small station, but is one delivering from 250,000 to 300,000 gal. of water a day on our main line between Chicago and Cairo. The cost of operation for the 12 months prior to the installation of the oil equipment was $4,027. The estimated cost of operation, based upon the first couple months' operation with the new plant is $2,200 per year. However, on checking up further we find that the expense is really going to run less than the estimated amount. The cost of coal for the steam plant was $1,600, while the cost of oil is going to run less than $800. The steam plant required two pumpers working ten hours a day each, which made a total cost of well over $2,000 for wages. The oil plant is handled within eight hours by one man, without overtime. Of course the saving depends on what you pay your pumper, but it aggregates about $800 or $900. The cost of unloading coal was nearly $700, for it had to be unloaded from the main line. This is an example of what can actually be accomplished in a large station. There is one consideration that I am afraid many lose sight of, and that is the fact that under present conditions we have to do our work within eight hours or pay penalty time. That is where the oil engine has a great advantage. Of course, you will have to build your units larger. These particular units are 500 gal. units, and we also have sufficient storage to handle a day's supply of water within eight

hours. I merely present these figures to show that the saving is not only in the small station that you can operate with the agent and the section foreman, but in the larger stations as well. Also it appears to me that one can do a lot of frostproofing and frost protection work for $2,000 a year.

G. W. Andrews:—I would like to ask Mr. Knowles just how he reached the conclusions as to the vast difference in the expense of operating the steam plant he speaks of as compared with the gasoline or oil plant? He gives one item of two pumpers working 10 hours a day each, or a total of 20 hours, and for the oil pump he gives a time of 9 hours. We must naturally assume that if he pumps a sufficient quantity of water in 9 hours with the oil pump as against 20 hours for the steam pump, he is using a much larger unit in his oil pump.

C. R. Knowles:—That is correct.

G. W. Andrews:—Now, then, if he installs a coal burning unit of the same size it would enable him to pump that same quantity of water which would, of course, eliminate one pumper, or 11 hours, which should be considered in that comparison. If he has a 500-gal. oil unit, and a 200-gal. steam unit, his comparisons are relatively unfair. He should draw his comparisons between pumps of the same capacity as far as the labor is concerned.

As you know, the B. & O. is among the pioneer railroads in this country. We have used every type and style of pump that has been made, even starting with the original lifting of the water by a bucket from the first stream the engine would reach after running low, and placing it in a barrel, which was the tank supplying the locomotive with water. From that on to the hand pump, such as we still use, and as the Egyptians used 4,000 years ago, the plain trough with a wooden stem on the end of it. It would push down as much water as it pulled up, but still that is the kind we used. Today we are using modern pumps of every type that have ever been made in this country, steam pumps, gas, gasoline, and fuel oil. There are a number of cases where we have found it of great advantage to use gasoline or the fuel oil for running the pump, with an increased saving by the installation of the kerosene carburetor on the gasoline pumps, which we have been exceedingly successful with, reducing the cost of operation nearly 50 per cent.

About 20 years ago when the gasoline pumps commenced

to be popular, even the manufacturers did not at that time claim any great economy in their use except where they could be operated by an employee who also had other duties and whose salary was therefore divided according to the work he did, which in many cases brought his salary as pumper down to as low as $10 a month. In some cases we paid him $10 additional to what he was being paid as a truck man or as an assistant around the station, or in other duties which would enable him to devote part of his time to the operation of the gasoline pump.

There are many places in which the gasoline pump is not practical. We have pumping stations which are flooded at various seasons during the year. I don't believe any of us would say that it was practical or economical to undertake to operate an oil burning pump or a gasoline pump under water, but we could still use the steam pump. We have one stretch of 100 miles of road which has been under water five times this year. There are five water stations on that 100 miles. Some of those stations have been as much as 20 ft. under water. You can see the position we would have been in, if we had gasoline installations there. As a whole I would say that the use of either steam or gasoline should be governed by local conditions, and the ability to economize more than anything else. We can operate gasoline pumps under normal conditions with economy providing we can have an operator do it at a reduced salary, or be paid the pro rata of his salary for the time devoted to the work.

Again, the question of ability to get coal enters. We are in a soft coal country and in a large percentage of the cases the coal that we use in our water stations is coal which we get for practically the cost of cleaning it up, and we have to clean it up anyway. It is coal which has been discharged to locomotives and has fallen on the ground. Where you have to haul your coal long distances and pay large prices for it, in the open market, gasoline and fuel oil are the fuels to use. They will possess very material advantages in cases of that kind.

C. R. Knowles:—I don't think I made myself quite clear in my comparative statement of the expense of operating the stations. These are the actual figures taken from the books. I neglected to state that we have duplicate units at our main line stations, each of 500 gal. capacity. The same thing is true of our steam plant. It was a 500 gal. pump—that is, it was rated at 500

gal.; but as a matter of fact, as you all know, we rarely got more than 350 gal. As Mr. Andrews says, it is probably not fair to give the full credit for the saving to the operation of the gasoline engine, although the great part of it is due to the installation of the engine. That type of unit made it possible. With the duplicate units, there are times where we have to use both engines, which means that we can throw between 800 and 900 gal. of water. I think you will agree that an expenditure for a steam plant of that capacity, that would even approach 60 per cent of the efficiency of an oil engine would mean an expense much greater than that for the installation of oil engines. Not only that, but with a plant of that kind you would have to have a more experienced man to operate it, and you would have to give him four hours a day additional for taking care of his coal, cinders, boiler feed pumps, firing up, cleaning fires, and similar duties necessary in the operation of a steam plant. It is difficult to get the exact figures on the saving. With the steam plant we used about 16 to 18 cars of coal a year, while with the oil plant we use one car of oil; and not only that, but there was a saving that cannot be figured in dollars and cents, from the elimination of interruption of the work of the track men.

Mr. Andrews was speaking of the low cost of coal. This particular station is in the midst of the St. Louis coal fields, but we pay the same price for coal at this point that we do other points maybe seven hundred miles away. Probably Mr. Andrews has a different condition.

Mr. Andrews also speaks of the coal wasted at tipples. That costs just as much as the coal unloaded in the pump house coal bin. It may not be charged to the water station, but the railroad paid for it, and I think any saving that might be figured in that connection would be merely a paper saving. Also, if the railroad thoroughly equipped with coal tipples is wasting enough coal to keep the water stations going, I think there is an opportunity for some improvements in the handling of coal at the tipples.

G. W. Andrews:—I am fully aware that Mr. Knowles pays the same price at the mine for his water station coal as he does for any other coal that is used, on the railroad, but he has the long haul from his mines, which, in some States he admits is 700 miles. Now as to the use of the coal from the tipples, as you all know, we have to clean it up anyway. They object to our

putting it back into the coal tipples for locomotive use, and the larger power plants dislike to use it, so in order to avoid throwing it away we use it very successfully in the way I stated. The cost of cleaning it up is not properly chargeable to the water stations, because we have to clean it up anyway.

When the price of gasoline went up as high as 28 cents we were forced to either go back to steam, or to install kerosene carburetors on our gasoline engines, which, as I stated before, we are still operating successfully, or to enter into the use of the fuel oil engine, several of which we have installed, and are operating successfully and economically. I don't want it to be thought for a moment that I am arguing against the use of gasoline or fuel oil engines where the local conditions necessitate the installation of a plant of that type, but I do say that we cannot consider them for use in all stations, eliminating steam plants entirely, until we find some way of operating fuel oil engines under water. As long as we can keep our steam supply out of the water, we can operate our pumps under water.

Another thing that we should consider is the fact that the ordinary steam pump can be repaired or replaced by the ordinary pumper until it gets in a condition that it is ready for junk, and if he doesn't know how, he can be taught how in a very few hours. The gasoline pump with its many intricate parts requires a skilled mechanic to take it apart and put it together again, and many of our pumpers are unable to do this.

C. R. Knowles:—Replying to Mr. Andrews' remarks in regard to operating pumps under water, it is true that a steam pump will operate under water, but not with any efficiency whatever.

G. W. Andrews:—It gives you the water, which you would not get otherwise, and which you have to have.

C. R. Knowles:—That is true, but you get a very low efficiency by operating a steam pump, or any other pump under water. We have oil stations operating on the Ohio and the Mississippi rivers, as well as the Big Muddy in Illinois and the Obion and Forked Deer in Tennessee, and if there are any wilder rivers in the country than the Big Muddy, the Obion and the Forked Deer I would like to see them. In a single night the elevation sometimes varies as much as 60 ft. We have one steam plant that it is necessary to operate under water every year. In installing our oil stations we put the pump in a frost-proof pit, and

drive it from an oil engine located above high water. We have a difference of 34 ft. between high and low water at Baton Rouge, La., on the Mississippi river, and at Graveswitch, Ky., on the Tennessee river, we have a difference of 60 ft. between high and low water, but at this point we have our pumps in a water-proof pit. It is a triplex pump driven from a power head located above high water. In that case there would be no difference between the steam pump and the oil pump operating under water, except that the oil pump would show the highest efficiency because you would not have the loss from condensation. If you are going to put in an oil or a steam station, you should locate the pump so it will not be flooded, if you are going to expect full efficiency.

L. A. Cowsert:—After the coal reaches our side-track we have to haul it a half mile to the water station, which costs about three to five cents a bushel. We secure a saving by using oil with a gravity flow from the side-track to the water station. At all such stations we are using oil engines with a storage tank at the side-tracks, so that we can connect a 2½-in. pipe into the oil tank and fill the storage tanks, then run a small line a half mile to the water station, and have another small storage tank at the engine. This is all gravity flow. In this case we effect a saving of fuel of 50 per cent, while we save more than 20 per cent on the cost of fuel oil over steam, where we can unload the coal at the station. This has been demonstrated for about five years. We have had experience with gasoline engines with coal oil carburetors, and also with the two cycle engine burning fuel and coal oils, which I think is the most economical type that we have found.

In regard to the operation of a pump under water, I also have had that experience and I think that it would be very expensive in any station to operate a steam pump under water; while it is sometimes expensive to get the pump away from there, you can put the pump in a pit, as Mr. Knowles suggested, and operate it with a belt drive. We have a centrifugal pump at Williamstown, Ky., in a 20-ft. pit, operating with a belt drive from an oil engine two feet above high water level. I agree with Mr. Knowles that the oil engine shows a saving of fuel. We are in a coal region too, where we can get coal easily, but the expense of handling this coal after we get it is increasing every day with us. In all of our stations where we can change to oil engines in the future, we are going to do it.

E. A. Demars:—At the present time we have an inexhaustible supply of coal in the United States, but the supply of oil is continually getting more scarce, owing to the increased manufacture of different kinds of fuel engines. On one or two roads throughout the West they are seriously considering changing from oil back to coal. I consider that the changing out of steam plants to gasoline plants in certain locations throughout the United States would be more costly than keeping the steam plants in operation, owing to the increase in the cost of fuel oils at the present time.

F. M. Case:—On our road it has seemed that the installation of oil burning engines was more economical than coal. A coal pumping plant is a very wasteful thing, especially with a duplex pump. I think a triplex pump, operated by an expansion engine, would usually be more economical. The direct-connected gasoline plant doesn't seem to be just what we want. We are transmitting the power by belt, believing this to be much better than direct connection, but of course the relative efficiency of the two methods depends on certain local conditions.

G. W. Rear:—Burn equal quantities of fuel oil in an internal combustion engine, and under a boiler, and you will find a great saving in the internal combustion engine. However, that does not mean that a dollar's worth of fuel is going to produce the same amount of power. Some people may be able to get the coal by scraping it up; others may have to buy it and pay $17 or $18 a ton for it, the same as we do. Again, it is absolutely useless to attempt to compare a modern gasoline or oil engine with an old steam plant that is about ready to be scrapped. I have seen some roads get hold of an old boiler that was not of much use anywhere else, and a simple steam pump, and connect the two up together. The result is that the boiler is eating up more coal than it ought to, to provide a certain amount of steam, and the pump is eating up twice as much steam as it ought to, to supply the amount of water. The cost of the water is what it costs to get it into the tank.

Then there is the question of attendance. All plants have to have some kind of attendance. It may be that one can fix it up with either a steam plant or an internal combustion plant so that it may need comparatively little attendance. Very often a pumping station is just outside a roundhouse where one can take the steam from a central plant and the running of it costs practically

nothing. In that case one ought to put in a modern plant, with compound pumps, and use the steam as economically as he can. With the gasoline plant one may have to have just as much attendance as with the steam plant. The plant may be located 50 miles from nowhere and the attendant has to live there while his only source of revenue is the running of that plant. I recall an ingenious installation located on a section of track 50 miles long on our road, that was intended to be electrified as soon as it was completed. During the construction of the four water stations on it they employed a pumper with a motor car. He started out in the morning, starting each pump as he came to it. A trip connected with the ignition system shut off the engine automatically when the tank was full. After having his lunch he came back and started them all up again. When the tanks were full again the trip would shut off the power. That worked out all satisfactorily for about 18 months, and they pumped a considerable amount of water.

It is a scientific fact that the internal combustion engine uses its fuel much more economically than the steam plant, but it is also useless to compare a modern internal combustion engine with an old plant that was hurriedly gotten together. It is possible to get together a steam plant that will give the internal combustion plant a hard run for its money, especially where you can get coal at a very low price.

C. R. Knowles:—Some may have the wrong conception of the comparative increase in the cost of fuels. I don't think you will find that oil has increased to the same extent that coal has. I heard someone remark about an inexhaustible supply of coal. I don't think there is an inexhaustible supply of coal nor an inexhaustible supply of oil either. I am not prepared to say what supply of either there may be in the earth, but I do know that there is a constant increase in the number of autos in service and that today you cannot buy one under six months' delivery, and the auto is using an oil similar to that used in our engines, so I don't think we need to have any fear as to the supply of oil being exhausted. If it is, I think there will be some substitute that will answer quite as well.

J. T. Andrews (By letter):—Considerable stress is laid upon the value of the fuel oil engine as compared with steam pumping. I believe that there is no question as to the value of the fuel oil engine for use in pumping plants under certain conditions.

Where a new installation is being made and especially, if local conditions are such that partial attendance can be had, the fuel oil installation will be much more economical than steam.

One feature, however, which is usually overlooked in discussions relative to the installation of internal combustion engines, is that it is often impossible to assign a competent man to do pumping during only a part of the time. The practice of having station agents, baggagemen, etc., look after pumping equipment, very often results in serious damage to the pumps and engines, due to the lack of proper attention, and it will usually be more economical to pay a full time pumper rather than to run the risk of breakdowns and serious delays due to such causes.

Fuel oil engines are expensive and unless a saving in the labor charges can be made, their operation is no more economical than steam at our present prices. Gasoline at present market prices is entirely out of the question, as the high cost of fuel itself will probably more than overbalance any saving which can be made in labor charges. The use of kerosene, however, is to be recommended, either in an engine built for that purpose, or in a gasoline engine equipped with a proper carburetor, in such cases where any part time pumper can be used. I do not, however, consider that kerosene installations are of as much value as fuel oil, except for comparatively small plants of light horse power.

In general, I would not recommend the changing of existing steam pumping plants to either fuel oil or kerosene, unless it can be shown clearly that a decided saving in labor can be made without consequent detriment to the pumping equipment through improper maintenance or operation.

Another point which should be considered is that steam pumps, especially the smaller and simpler types, can usually be kept in fairly good repair by the pumpers themselves, while internal combustion engines generally require a large amount of maintenance by expert mechanics. Probably the most undesirable present feature about steam plants is the necessity for having regular boiler inspections made under Federal laws, and unless the charges attendant thereon are kept under proper control, this is liable to result in a very heavy charge for boiler inspection.

PAINTING METAL RAILWAY STRUCTURES

Report of Committee

Questionnaires were sent to seventy railway officers asking for information on the subject assigned to this committee for consideration, from whom we received seventeen replies.

Naturally the first operation in the painting of a structure, and one which should receive a great deal of attention, is cleaning. The greatest enemy of steel is rust and to make a job of painting successful the rust must be thoroughly removed. All of our correspondents specify scrapers, wire brushes, chisels, and bars for this purpose, and three use the sand blast occasionally. There can be no doubt that the sand blast is by far the most thorough method of cleaning, but the cost is excessive and it is not generally used on that account. Some of our correspondents specify sledges and bars for the removal of rust, but it would seem that a structure that is so rusty as to require such heroic treatment would be seriously weakened and would indicate faulty methods of inspection.

All are agreed that the first coat of paint should be applied as soon as possible after cleaning, providing the steel is dry, as paint will not adhere to a wet surface. The use of sprayers is not advised, 16 of our correspondents reporting unfavorably while one says he believes it to be as good as brushing but remarks that he has had no experience.

The operation of brushing is of vital importance and should receive more attention than it usually does. We find in various instructions issued on the subject of steel painting that none but good mechanics should be employed; this brings up the question of what is a good mechanic. Because a man is a good house or carriage painter, it does not follow that he is a good steel painter; in fact, the opposite is found to be the case in many instances. In painting steel only enough paint should be used to cover and that should be thoroughly brushed, mixing it with whatever rust or other impurities may have been left on the surface and working it into all crevices. The thorough brushing of paint on steel is essential as rust begins to form as soon as the metal is exposed to the air and the brushing will tend to mix and incorporate whatever rust has formed with the paint. The best results are obtained by the use of brushes that have been worn considerably, as the temptation to lay the paint on too thick and then smooth it out is very great when using a new long bristle brush.

Some are inclined to advocate the use of the round brush, but the shape of the brush does not make much difference if the bristles are not too soft and long and sizes are used which will enable the painter to reach all the interstices as well as the broad surfaces.

The question of the material to use for the different coats was answered by 13 of the correspondents in favor of red lead in some form for the primer. While there are a number of inhibitive pigments on the market, none enjoys the popularity of red lead for this purpose. One correspondent favors the addition of white lead in the proportion of one-third white to two-thirds red; another advocates the addition of one per cent of lamp black with the idea of filling voids in the coarser red lead and tending to make the paint denser and more impervious to moisture. The addition of litharge was advocated in one instance but we are informed that litharge is contained in all red lead and is considered an impurity. A proprietary paint is used by four of our correspondents.

For the succeeding coats the preference is about equally divided

between lamp black and graphite, while two report the use of brown mineral with satisfactory results.

The method which seems to be giving the greatest satisfaction and to be followed most universally is to prime with red lead, the second coat to consist of a mixture of red lead and lamp black and finish with lamp black and graphite. The object of mixing red and black so as to make a brown for the second coat, is that, it being a different color from either of the other coats, it is easier to see when the work is covered; and the addition of the finer pigment to the coarser makes a better paint on account of its greater density.

Only one of our correspondents reports the use of any other oil than linseed; in this case soya bean oil receives favorable mention.

The addition of about six per cent of turpentine is recommended in nearly all cases to assist in penetration and to give the paint better spreading qualities. This is not to be considered a substitute for linseed oil, but is added to the paint for a specific purpose.

Climatic conditions have a great influence on the durability of paint; the temperature does not seem to have much effect as we have reports from the high cold mountains of Montana and the low hot valleys of Arizona in which the life of similar paints is identical; although the temperature is from 50 to 60 deg. apart most of the time. The shortest life of paint is reported from the coast regions where the atmosphere is damp and warm and impregnated with salt, where in some cases painting must be done every year. The longest life of paint is reported from Montana and Texas, in which territories 15 to 18 years elapse before it is necessary to repaint.

For experimental purposes, one span of a seven-span deck plate girder structure over the Snake river at Idaho Falls, Idaho, was painted with a proprietary paint composed of some bituminous substances while the remaining six spans were painted with the regular standard bridge paint, composed of red lead, 10 per cent, lamp black, 50 per cent and inert material, 40 per cent; the vehicle specified to make a paste being raw linseed oil; boiled oil was used as a thinner in the field. Whether the linseed oil was kettle or bunghole-boiled we do not know, and we are equally ignorant of the composition of the inert material. The standard paint has made a good showing for itself, being in perfect condition after ten years of service, while the bituminous paint has disappeared except a light layer of black dust which was easily removed with a scraper and duster. The primer used on this bridge was red lead and linseed oil, and it must have been applied exceptionally well for, although the bituminous coating has practically disappeared the steel is in perfect condition, no rust spots having developed.

The materials used on water tanks and coaling stations do not differ materially from those used on bridges, except that in a few instances the inside surface of water tanks has been painted with hot tar.

The replies to the question whether water tanks need painting oftener than other structures are equally divided, seven declaring that they do and seven that they do not. Some extra precautions are necessary to prevent rust at the footings on account of the spilling of water from engines, in most cases an extra coat of paint being applied. Where a pocket is formed by the plates at the bottom of the pillars, filling the pocket with cement concrete is an excellent method of preservation.

No satisfactory results have been reported from the use of special coatings on coaling stations, ordinary bridge paint giving as much protection against the fumes of engines as any special preparation that has been tried. No preparation to be used as a paint can give adequate protection to overhead members subject to the direct blast from locomotive smokestacks; all such members are better protected by a cement covering or a suspended slab of asbestos or other indestructible material.

The question of painting galvanized iron brought out a great many formulas for washes to be applied to the iron before it is painted. These

washes are supposed to prevent the paint from peeling, but none of them have any very enthusiastic advocates. The most successful method seems to be the weathering of the iron until the zinc coating is removed. If it is necessary to remove the zinc coating from the iron before it can be painted successfully, the zinc may as well be saved and plain iron used instead. The following chemicals are quoted as being used on galvanized iron for the above purposes: sal soda, sal ammoniac, hydrochloric acid, copper chloride, aqua ammonia, copper sulphate, nitric acid, benzine and turpentine.

C. T. Musgrave,
Chairman.

APPENDIX A

PROTECTION OF METAL STRUCTURES

By J. R. Shean, Pacific Electric Ry., Los Angeles, Cal.

The protection of metal structures is a subject which may be discussed in two parts—the first treating on steel structures, and the second, galvanized iron.

The protection of steel structures, which include bridges, structural steel and steel water tanks, is the great problem, as hundreds of thousands of dollars of every railroad's capital are invested in them. As their renewal, especially of bridges, is a very costly operation, on account of the necessity for doing the work without interfering with traffic it must be apparent to all that steel work should be started on its career of usefulness in the very best condition possible. While, in some instances, special treatment and material may be necessary on account of atmospheric or climatic conditions, as a general rule the same methods can be used for protecting all steel work.

The greatest enemy of steel is rust. Research and investigation have proved pretty thoroughly that it is caused by surface impurities, which may be carbon, cinder or oxide, and which, when the surface is wet, set up an electrolytic action that first starts the rust on its career of destruction. As long as it is left on the surface, it will continue to eat its way into the steel, until in the course of time, the whole structure will become so weak as to be unsafe for use.

Coats of paint will naturally retard the rust action by keeping the dampness away from it, but no paint has ever been made that will entirely kill rust as long as there is steel for it to act on. Bearing this in mind, no one can doubt that the money spent in cleaning the rust off thoroughly, before painting a new bridge, is money well spent. After years of practical experience, it has been proven that this work can best be done by the company's own forces as they have the structure to maintain afterwards and realize that a little thorough work done by them at this time will save a great amount of hard work and the company's money later on.

As a rule when the steel is new the rust consists of only light yellow spots here and there, and can be removed with scrapers, made from old files turned over at the end and retempered and sharpened. Stiff scrapers and putty knives are also useful at this time. Steel brushes are not of much real value, except to clean off dirt and loose mill scale. Any heavy seed rust which has formed a cup down in the steel should be chipped out with a hammer, and the greatest care should be taken, to be sure and get all the rust out of this cup so that the clear steel shows in the bottom. Care should also be taken to avoid cutting the steel unnecessarily with the sharp edges of the hammer. The sand blast is a very thorough way of cleaning steel at this time, but it should be followed at once with the first coat of paint, as the surface starts to rust again very soon after the blast is used.

After the surface has been thoroughly cleaned, the next question is what to use for a first coat of paint to give it the maximum protection against the rust getting another foothold. There are several "inhibitive" pigments, most of which are impractical for general use. The one which is generally accepted by engineers as being the most valuable is

red lead. This pigment has had many enemies among engineers and painters on account of its tendency to sag and run on vertical surfaces, and to settle into a hard concrete-like mass in the bottom of the container. These faults are caused by an excessive amount of litharge, which sometimes amounts to 30 per cent of the cheaper grades. In the last few years, some lead manufacturers, by finer grinding and reroasting, have reduced the litharge until the United States Government standard is true red lead 94 per cent and litharge 6 per cent. More improvement has been made, however, and now it is possible to buy red lead containing only 2 per cent of litharge, and 98 per cent true red lead (Pb_3O_4). This makes an ideal paint for first coat. Being extremely fine, it fills all pores, and brushes out in a smooth even film, free from voids. It stays in place on vertical surfaces and does not act ropy under the brush.

Another great advantage in using this high grade material is that it can be bought in paste form, saving the time it used to take to mix up the dry red lead by hand. The vehicle with which the red lead is mixed is fully as important as the pigment itself. The merit of linseed oil is too well known to need comparing with any other for this work, although the paint film is much better if reinforced with Japan oil. Elaborate tests, made recently, have proven that without reinforcing an oil film loses from 18 per cent to 23 per cent of its volume in 200 days.

This shrinkage of the oil film, which should hold the pigment together, is worthy of serious consideration and Japan oil or anything else which will truly reinforce it, should certainly be used. Japan oil also furnishes sufficient dryers of the right kind, as rosin dryers are a detriment rather than a help to red lead.

The amount of red lead to be used in one gallon of vehicle is a question upon which engineers differ. On the Hell Gate bridge, 37 lbs. of red lead were used to 1 gal. of vehicle, but this would only be possible with the very finest quality of red lead. The general average for railroad use is about 25 lbs. to the gallon of vehicle, or about 17 lbs. to the gallon of paint mixed and ready for use.

When steel work is to be red leaded at the fabricating plant, care should be taken to have the specification worded in such a way, that no misconstruing of its intention will be possible. In any case, the inspector should make it a point to see that the intention of the specification writer is carried out.

The coats of paint to succeed the red lead and to repaint the structure when necessary form a proposition upon which there is considerable difference of opinion. Some authorities insist that a carbon base is the best, others insist that graphite is, while others prefer mineral red or lamp black. Whatever the individual merits of these pigments are, and they probably are all good if applied right, the fact remains, that they are all heat attractors. As heat is a first class destroyer, it is hard to understand why it has become such a common practice to use these dark colors.

Unless the price of material is the main consideration there is no reason why steel work should not be painted in light colors, as their resistance to heat rays would certainly be easier on the oil film which holds the pigment together, than the dark colors which attract and hold the heat rays.

Canary yellow, pearl gray or light olive green will change an unsightly black structure to one that will at least be more in harmony with its surroundings. These light colors will last longer than the dark colors to pay for whatever difference there is in the cost of the two. It may be argued that light colors become unsightly in a short time from dirt and smoke. This cannot be noticed to any extent except overhead on through truss bridges and on overhead bridges, but even if painted black the smoke marks show considerably on this part of a bridge. The theory to follow when applying the coats which follow

the red lead, as well as any other time the bridge is painted, is to have the last coat of paint more elastic than the coat preceding it. This will insure against checking and alligatoring. Some authorities advise putting a little non-drying oil in the last coat, to make a better "shedder" of water. This would appear to be a good plan, provided it finally did dry hard by the time the bridge had to be repainted, so that the next coat was more elastic, thus avoiding the danger of checking.

A brushed-on coat is very much superior to one applied with a spraying machine on steel work, as the protection of steel depends largely on whether or not the paint is thoroughly brushed into the pores and then laid off in a smooth, even film. A spraying machine cannot do this, and while it is a timesaver, when applying varnish or a flat color and water colors, which flow out of their own accord, oil color has to be brushed to give the best results on steel. Some advocate spraying and then brushing. This does not solve the problem, as the brushing in this case generally consists in drawing the brush over the surface once and smoothing it out. If work is sprayed and then brushed as much as it should be, the only saving is doing away with the necessity of dipping the brush in the paint pot. The practice of painting a bridge with a four-inch brush and perhaps one sash tool is a very poor one. Different kinds of brushes should be furnished and the workmen should be required to use them, to get the paint in every nook and corner and between angle braces, etc. It is in these inaccessible places that rust does the worst damage if once allowed to get a foothold.

The tools needed for cleaning the work before repainting are about the same as for new work. Light chipping hammers are indispensable for getting the rust-scale off. For cleaning the dirt off, a small bunch of broom corn wrapped with twine, makes a very handy tool. After the dirt has been loosened with the broom corn, it can be brushed off easily with the duster. This saves considerable scraping with the putty knife.

If a structure is properly treated when it is new, there is hardly any need of using a sand blast for repainting. The rust will only show where it is able to push the paint off and these spots should be chipped out until the cup formed by the rust shows the clear steel. Holding the blast on one of these spots until the cup is clear of rust will cause considerable unnecessary cutting of the steel around it. After the rust is cleaned off, the bare places should be spotted with good red lead and then painted the same as the rest of the bridge. If this work is done thoroughly there is no reason to expect further trouble from these places, but if it is not, it is only a matter of a short time until the rust will be at its work of destruction again. On overhead structures, where the hot cinders from the smokestacks strike with considerable force, no paint can be expected to give the needed protection without some sort of a fender for them to strike against.

After the painting is done something should be devised for this purpose and placed over the tracks to take the full force of the sparks. A great deal of harm is also done around bridge seats by the dirt and cinders which are generally allowed to gather on the abutments for when this mass gets wet, an acid is formed, which not only ruins the paint film, but also induces rust action. On every road some one should be responsible for keeping the abutments clean, at least to the point of not letting the dirt accumulate until the bridge end is buried.

Steel water tanks should receive the same general treatment as other steel work. The additional cost of an extra coat of red lead on the inside of the tank is money well spent. A good quality of linseed oil reinforced with Japan oil should be used in the finishing coats on tanks as water has a tendency to soften the oil film, and, as every one knows, there is always more or less water splashing around. Pockets without outlets should be filled with concrete wherever it is practical to do so, especially at the footings.

Substitute oils are becoming very common now and some will do

fairly well if reinforced, but the fact that at the best they are only substitutes should be borne in mind when using them, especially on tanks or near the coast where there is considerable dampness in the air.

The painting of new galvanized iron is a very unsatisfactory problem as the paint is almost certain to peel off in time. This may be caused by the hard, polished surface of the galvanizing not giving the paint a foothold. The same conditions are met in painting smooth aluminum. There is more or less impression among painters that the peeling is caused by acid on the surface, but such is not the case. The process of galvanizing consists of pickling the material until it is perfectly clean. After drying, it is immersed in molten zinc, heated to approximately 850 deg. F. until the material has attained the same heat; after being removed and cooled off it is ready for use. How any acid can remain after this torrid experience is a mystery. The acid theory for the cause of peeling is discounted by the fact that a wash made of one ounce each of copper nitrate, copper chloride and sal ammoniac crystals, dissolved in soft water and then one ounce of muriatic acid added will change the surface so that paint will adhere very well. This wash turns the galvanizing a dark slate color and probably removes a good share of the zinc coating, allowing the paint to get a hold on the iron itself. Whether it does or not there is more chance for the acid to affect the paint than there is after it has been heated to 850 deg. F. The wash described should be applied with a soft brush or a swab, and when it has dried, the fine powder which is left on the surface should be brushed off. Having in mind all the trouble and uncertainty regarding paint or galvanized iron the question arises in one's mind, why paint it at all? If for certain reasons a building has to be painted why not use straight corrugated iron and paint it for protection. The cost of galvanizing iron in a first-class manner is from three cents to five cents per pound and as every one knows the iron can be painted for less than that. If a galvanized iron building has to be painted when new, and it is impractical to apply the wash, a priming coat of good red lead with considerable turpentine in it will give fairly good results. Roughing the surface by rubbing lightly with coarse sand paper will help the paint to hold. The best system to follow is to let a structure covered with this material stand without paint until the galvanizing is about worn off by the weather, and then paint it before rust has a chance to form. There is no reason why it should rust if given a fair coat of paint, as the iron is perfectly clear of rust or dirt before it is possible to galvanize it.

APPENDIX B

By G. G. Mowat, Cleveland, Ohio

The specification prepared by the engineer and the chemist, for the purpose of creating an efficient protective covering on structural steel, is the result of considerable experimenting. The seat of the trouble is in the chemical affinity between iron and the oxygen of the air. Dry iron and dry air have no action upon each other at ordinary temperatures, but in the presence of moisture and the other gases contained in the atmosphere, a chemical reaction takes place with the formation of "rust," which is a hydrated ferric oxide, or iron oxide, and is much the same as a limonite iron ore from which iron may be extracted in the blast furnace.

The rust which forms in the oxidation, or hydrolysis of iron takes up almost two times as much room as the iron which it replaces, hence the paint or protective film will be pushed away. The rust is a moisture absorbent, and usually carries not less than 24 per cent of water held in its pores, which water acts as the source of further corrosive action.

Origin of Structural Steel

A few words about the origin of structural steel. The blast furnace is a pot or crucible into which is charged a mixture of iron ore, coke and limestone. This is subjected to a hot air blast. The air reacts with the carbon of the coke to form a lower oxide of carbon. This in turn, at the high temperature prevailing, takes oxygen away from the iron of the iron ore, and thus liberates the metal in a molten condition. This metal, known as "pig iron," contains much carbon, and air is blown through the still molten metal in an apparatus known as a converter. After having been changed to steel in the converter, the liquid is cast into blooms, and these may then be rolled and forged into structural shapes.

Owing to the high temperature at which the shapes are rolled or forged and the necessity of having this process take place in the air, each shape is covered with a coating of black magnetic iron oxide or "mill scale."

Now the peculiar thing about this "mill scale" is that it is quite inert towards the corroding action of a damp and smoky atmosphere, and hence, if it were not brittle by nature, but as tough as the steel underneath it, it would serve as a good protective coating for the steel. But some of it is bound to chip off during handling and transportation, and it always is the source of quick corrosion of the underlying steel when moisture and atmospheric gases furnish the go-between for the rusting process; for the mill scale and the iron constitute the positive and negative elements of an electrical battery and the moisture and acid gases furnish the vehicle for the electrolysis, which results in the attacking and removing of valuable iron substance. The engineer's specification therefore calls for a complete removal of all "mill scale," and this cannot be effective by the use of the whiskbroom and putty knife. Sandblasting, wirebrushing and pickling are three methods of removing mill scale and rust. The former are mechanical processes and the latter is a chemical one. The chemical process of pickling is an expensive one. Hot dilute sulphuric or muriatic acid, or mixtures of either of these with hydrofluoric acid, may be used for the pickling treatment. When the mill scale has been loosened sufficiently, the piece is removed from the hot acid bath, and subjected to a powerful stream of water, which helps to wash off the scum resulting from the process. The work must then be given a bath of hot milk of lime to insure removal of all acid.

It is then dried best by the use of artificial heat. The coating of lime is brushed off just before the metal is to be painted.

Sandblasting is more economical of space and labor, and practically any location is accessible to the sandblast, so that it is most frequently used.

After the surface has been thoroughly cleaned, so as to be practically a bright metallic one, the work is ready for the priming coat.

The careful removal of all rust should be followed immediately by the application of the priming coat.

What Paint Is

As we all know, a paint is a liquid consisting of a vehicle with a pigment in suspension. A few pigments have been discovered or are known to us, which take the place of the expensive Bower-Barff treatment. When in contact with the clean iron surface and in the presence of moisture these pigments produce a continuous insoluble, inert coating on the iron.

Such pigments in the order of their utility are: Chromates of zinc and of lead; red lead and orange mineral; and black oxide of manganese.

To know what kind of a paint is the best one to use for a given purpose, is a matter of experience, and experience is a hard taskmaster. It is well to know also a little of the theory why a certain deterioration takes place under certain circumstances and not under other conditions.

It is a recognized fact that the practical value of all protective pigments depends on their atomic fineness, density, favorable specific gravity, immunity from atmospheric influence, ready ability to amalgamate perfectly with linseed oil and remain in suspension during application.

Commercial Red Lead

Commercial red lead usually consists of about 85 per cent true red lead and 15 per cent litharge. If we remove the litharge chemically we may obtain a true red lead. A paint made up from this pigment and raw linseed oil will not dry properly, and a dryer or siccative must be added to attain a practical rate of drying. Litharge, on the other hand, combines or saponifies fairly rapidly with raw linseed oil.

It has been proved that red lead serves best when used on structures submerged in water, such as ships' bottoms, turbine wheels, channel and harbor signal devices, bell buoys, etc., for when exposed to the air and to contact with sulphurous gases it has a tendency to disintegrate rapidly. It has been found that superior inhibitive results joined with greater durability are obtained when a mixture of metal chromes, pure iron oxide pigment and powdered silica is used in the paint for the priming coat.

Ferro chromes are used by British manufacturers in making stainless steel cutlery. A formula that combines these constituents in correct proportion has long been recognized by authorities as a most effective and economical primer for iron and steel. Sulphurous gases and fumes from passing locomotives have a tendency wherever there has been an abrasion of the finishing coat on a steel bridge to disintegrate red lead when it has been used as the priming coat. This disadvantage is overcome in the use of a formula as outlined above.

Another point which has some influence on the durability of a paint film and on its non-permeability is the fineness of the particles.

No single coating will present all the features desirable in a protective film. Experience has, therefore, led up to the following practice:

1. Complete removal of mill scale, old coating or rust, as the case may require.
2. Application of inhibitive coating.
3. Application of first protective coating.
4. Application of second protective coating.

Experience has shown that it is productive of good results to care-

fully apply one or two shop coats of primer in oil, letting each of these set properly, then when the work is in place to go over and repair any deficiencies of the priming layers. The second coat should be slightly different in color, and contain some inert pigments and linseed oil, and a final elastic black coat of inert pigments and linseed oil is then applied. It is advisable that the inhibitive coating should vary in color from the protective coating—the difference in color serving to prevent imperfections in application.

The value of cleaning and painting structural steel is a material one in the total cost of completely erecting a structure. If it were not for the possibility of protecting steel structures with inhibitive and sealing coatings in this way, we would have to surround them with Portland cement or with nobler metals.

The rules for the proper protection of steel are not always observed, and millions of tons of steel structures are hastening to premature decay because of shortsightedness and skimping, while other millions of tons are at least fairly well protected.

APPENDIX C

Paper read before Houston Engineers' Club, May, 1919
By Tom R. Wyles

Protection for Steel Structures

The great need for the conservation of natural resources makes it more than ever necessary that the subject of the preservation of iron and steel structures receive most careful attention.

At the present time no absolutely permanent protection for steel is known and although paint is accepted as the most efficient protection, the subject is not always given the technical attention which it merits.

To obtain the maximum protection at minimum cost, it is necessary to appreciate the factors governing the situation. These are as follows:

1. The electro-chemical technical explanation of corrosion. (Accepted by the leading authorities as the true cause of corrosion.)
2. The condition of steel as it is turned out from the rolling mills.
3. Modern fabricating shop practice.
4. The requirements necessary for various exposures.

The electro-chemical explanation of corrosion, briefly stated, is as follows:

Every metal, when placed in water or in an atmosphere which acts as an electrolyte or in such conditions of exposure that a film of moisture may condense on it, tends to dissolve. This tendency is governed by impurities, unequal stresses and unhomogeneous nature of the metal in each case and by the impurities in the liquid or gaseous film. Certain points in the metal, which have varying tendencies to go into solution, form electrodes of opposite nature and corrosion takes place in proportion to the potential difference between these points, governed by the value of the electrolyte connecting them. The more concentrated the hydrogen ions in a solution (as in acids), the higher will be its electric conductivity and the more rapid, consequently, the corrosion of the underlying metal. It is clear, therefore, that in a fabricated structure this action between points applies to each surface in detail but to the whole structure of which the members are of varying composition or subject to varying stresses.

Owing to the process of manufacture by heat, steel plates and shapes are always coated with scale which is the black magnetic oxide of iron. This, though it has at first a metallic blue sheen, is not part of the metal, and as it is electro-negative to the steel or iron, it forms a surface which actively promotes corrosion from the moment it is exposed to the atmosphere. This corrosion is hastened in proportion to the amount of moisture in the air and any acid present.

The mill scale as it corrodes changes into a hydrated red oxide of iron holding 24 per cent of hydroscopic moisture which is never dried out under atmospheric heat conditions, but acts as an accelerator of further corrosion. As this change takes place the scale increases to more than double its bulk, gradually loosens and flakes off.

No paint applied on top of corroded scale, even though the oil penetrates the scale, will stop this corrosive action or bond the scale to the underlying metal. The paint merely acts as a covering under which the moisture in the scale will vaporize and creep. The increasing bulk of the corroding scale will lift the paint skin from the metal, breaking the waterproofing skin of the paint and the process of corrosion will continue. Once corrosion of the steel, therefore, is started greatest care should be given to cleaning the surface. It is better to have the mill scale corroded right off, as in marine practice where vessels are built on

open ways and the hull is left to corrode during the construction period, than to only partially clean the surface and leave particles of corroded scale under the paint.

In shop practice, however, it is not always possible to remove entirely anything but the loosened or corroded scale. Blue mill scale adheres so firmly to the surface that it can be removed only by the use of a sandblast or by the pickling process. Either of these methods makes for excessive fabricating costs and, therefore, for general work the blue mill scale is left on, and only the corroded scale which it is possible to remove by the use of hammers, scrapers, and steel wire brushes is taken care of. Shop practice also is governed by the speed of production, the labor situation and the shapes of sections, all of which affect the amount of work which can be done on cleaning, and it is, therefore, necessary to design the first or shop coat of paint in such a manner that it will, by its anticorrosive and electro-chemical insulating qualities and by its adhesion, prevent corrosion from spreading and counterbalance the shortcomings of practical workmanship to obtain maximum results.

Information Governing the First Shop Coat of Paint

As the functions of this coat of paint are to take care of the electrochemical corrosive action outlined, to form a base on which the exposure or field coats are placed and to overcome in the most effective way possible the shortcomings on the conditions governing even the best shop practice, it is very necessary that this paint receive most careful consideration.

It must be composed of especially pure ingredients which make the paint thoroughly neutral and from which all free acids have been eliminated in order to avoid chemical action between the paint and the steel. The paint must also resist the passage of electric currents, as otherwise the steel will be subject to electrolytic action. It must protect the steel against the action of moisture or gases during its transition through the fabricating shops and for a period long enough to allow the steel to be erected, as otherwise corrosion of the surfaces is started before the exposure or field coats are applied.

It must dry hard with strong adhesive qualities, and yet be sufficiently elastic to resist handling of the structure through the shops and to offer an effective surface against the extreme ranges of our severe climates with 120 degrees Fahrenheit temperature range, otherwise after a short life it will crack and allow moisture to attack the steel.

It must be a reasonably light coat as otherwise when used as an assembly paint between surfaces in contact where hot rivets are driven it will burn out and cause loose rivets. It should be easily spread in order that it may be worked into all portions of a built-up section without difficulty by the shop labor.

One of the causes of high maintenance costs in steel structures is the practice of letting a structure stand exposure until not only the field coat of paint has lost its vitality, but corrosion has eaten right through the shop paint and bare portions of steel are exposed, thereafter applying one coat of field paint. It should be remembered that in many cases the most effective field coat is not a proper shop or anticorrosive paint. If corrosion is far advanced on a structure, at least two coats of paint should be applied after the surfaces have been thoroughly cleaned. and the first of these should be a real anticorrosive paint fulfilling all the requirements of a shop or construction paint. The second coat should be one which will protect the first coat and offer greatest resistence to the exposure to which it is subjected—i. e.. atmospheric-normal, atmospheric-acid fumes, under water, underground, etc.

Information Governing First Field Coat of Paint

The functions of this coat of paint are to reinforce the shop paint

and to take care of any portions of the steel work which have been improperly covered or become scratched in transit through the works. It is good practice when surfaces are bare of paint, caused by transit, erection and riveting, these spots including new rivets should be wire brushed and painted before applying a complete field coat; otherwise, uniform protection is not given.

To appreciate the necessity for this coat, one has to have experienced the maintenance of steel structures on which it has not been applied or had access to practical exposure tests of paints. It is absolutely necessary on very light structures such as transmission towers where small thin sections are used in the construction, as the sharp edges of these are hard to cover properly with one shop coat and in such structures the varying nature of the stresses usually makes corrosion conditions extremely severe. It should always be applied where severe weather conditions exist such as strong sun, high wind, large variations of temperature, etc.

It must be strictly an anticorrosive paint similar to the shop coat but have in its makeup more of an oil life than hard drying properties as it must also help to reinforce and feed subsequent coats.

It should be slightly different color than the first shop to insure absolute covering.

Information Covering Exposure or Second Field Coat of Paint

The function of this coat of paint is to withstand exposure to which the structure is subjected, and consequently it must be designed to suit.

The whole value of the shop coats will be lost if the field paint is not suited to its purpose or if it is improperly applied. Wherever possible this coating should be selected to meet service conditions—viz.:

Atmospheric, general.—A good linseed oil paint.

Earth acids. Buried tanks, pipes, penstocks, etc.—Either a hard gum coating or well refined asphalt. No tar.

Alternate submersion. Turbines, lock gates, bridge piers, etc.—A special hard drying oil paint.

Acid fumes.—Special coatings are made for unusual conditions.

Salt spray and sea fogs.—Great care must be taken on previous coats. A good boiled oil paint well applied is serviceable.

DISCUSSION

(Painting Metal Railroad Structures)

J. L. Pickles:—I would like to take exception to the last paragraph in the report, which suggests waiting until the zinc coating is removed. You want to wait until the zinc is oxidized and then the paint will adhere to it. If you wait a couple of years you still have a coating of zinc that will protect the iron.

A Member:—Before painting galvanized iron we always apply vinegar and then wash it off, and we never have any trouble with our paint.

Mr. Ettinger:—The paper does not fully explain the use of tools. It merely says, "Use that tool." We give our men the tools and 95 per cent of my trouble, at times, is to get the fellows to use them. I have seen paint applied directly upon a heavy casing of rust. I found one by actual measurement only the other

day, ⅜-in. thick. It is a waste of time and of material to spread good paint over a coating of rust, proving that the use of the proper tool is more necessary than the providing of the tool if you are going to leave it in the tool box.

" It would seem that a structure that is so rusty as to require such heroic treatment would be seriously weakened and would indicate faulty methods of inspection." To that, I believe should be added the words " or application."

Further down the report we read, " The operation of brushing is of vital importance and should receive more attention than it usually does." That bears out my remarks, and explains the non-use of the spray. There is very little absorption to steel. The surface is smooth, at times, and the only way you can get anything to adhere is to brush it in. A spray doesn't do that. It only forces it to the surface, and it then rolls down. Furthermore, in using a spray you have got to make your material so thin that you have to use volatile liquids, such as turpentine or benzine in order to force a rapid evaporation and to get the film to set. To do that you cut the life out of the paint. I wish that some spray could be invented to do the work, for one reason more than any other—to reach the inaccessible portions of bridges.

A further remark in that same paragraph calls attention to the fact that in painting steel, " We find in various instructions issued on the subject of steel painting that none but good mechanics should be employed; this brings up the question of what is a good mechanic. Because a man is a good house or carriage painter it does not follow that he is a good steel painter." That is a question for us men in the field to solve. We must make our mechanics. We must teach them this work. If we don't we are lax in our duties. The best all-round mechanics that I have are the men of my own training.

The next paragraph reads—" Some are inclined to advocate the use of the round brush, but the shape of the brush does not make much difference if the bristles are not too soft and long." That brings me back to the old days when we did use the round brush. Forty-five years ago the flat brush was not known; the round brush was the only one used, and it is the only real brush today. It contains more bristles than the flat brush; it contains more power; it covers more surface. Not long ago a so-called " old-time man " came to me for a job. I happened to have a

ball of twine and a round brush lying on the desk. This fellow talked about being an old-time mechanic. I said to him, " Take this ball of twine and take this round brush and bind it up for me. Show me how you used to do it." He looked at me as if he thought that I was crazy. This fellow hadn't learned as much as he claimed, and the consequence was that he didn't get the job.

" The question of the material to use for the different coats was answered by 13 of the correspondents in favor of red lead in some form for the primer." That stands undisputed. Red lead has a natural affinity for steel. It is a so-called " inhibitive pigment." But there isn't as much in the inhibitive story as we think. There are many red leads in name, but high grade leads that do the real work contain from 94 to 98 per cent lead. Red lead and litharges are the same, litharge being the dryer or the coarse material in the red lead. The more of this litharge you take out, the finer the red lead becomes, the more oil you can take out, the easier it will brush, and the more affinity it will have for steel. About ten years ago government chemists asked for nothing less than 94 per cent of pure red lead, meaning that only 6 per cent could be dryer, or litharge. Red lead is, I believe, more extensively used than any other primer. I find in my experience, though, that a high grade ferric-oxide, containing from 85 to 92 per cent of pure oxide, comes very near to it. In days gone by we had to mix red lead by the batch. I remember the first job I did I could mix only half a day's supply at one time. That shows that at that time we didn't get red lead; we got more litharge or dryers. By noon that batch was putty; it dried up so rapidly. But since that time science has gotten away from that and today we can get the product that we want. You have to have red lead, not in name, but in fact. It must be at least 94 per cent. If you get anything below that, you have a coarse, rough coating, and you are going to have trouble.

" One correspondent favors the addition of white lead in the proportion of one-third white to two-thirds red; another advocates the addition of one per cent of lamp black with the idea of filling voids in the coarser red lead and tending to make the paint denser and more impervious to moisture." Here is a contradiction. Put lamp black into a bottle with a mixture of red lead and leave it stand and you will find the red lead at the bottom and the lamp black coming up, showing that it doesn't fill voids. It is put in there to darken the red lead; that is all. It is

not a filler; it is too light for that. "The addition of litharge was advocated in one instance but we are informed that litharge is contained in all red lead and is considered an impurity." Litharge and red lead are identical. Red lead, before it becomes such, is litharge, or dryer. We take away the litharge, in order to make the red lead finer, to make it receive and take up more oil. It is the oil that really makes the life of the paint. The more oil we can squeeze into the body of the paint, the better we are off. Take, for instance, lamp black. In 100 lbs. of lamp black, you will find 80 lbs. of oil and 20 lbs. of lamp black. Compare that with 100 lbs. of red lead, which contains 93.5 per cent of red lead and only 6.5 per cent of oil. You have 80 lbs. of oil in the lamp black and only 6.5 lbs. in the red lead, showing that the lamp black takes up a great deal more. That is why we use black as our surface coatings. It takes up more oil and gives a film that is more impervious to water and easier of application.

"The method which seems to be giving the greatest satisfaction and to be followed most universally is to prime with red lead, the second coat to consist of a mixture of red lead and lamp black and finish with lamp black and graphite." We add a little black to the red in order to give us a guide. Supposing you let the bridge painting by contract and you want to see how the contractor applies each coat. You can then see a spot that has been missed readily and you can call his attention to it.

"Only one of our correspondents reports the use of any other oil than linseed; in this case soya bean oil receives favorable mention." It is the hardest thing on earth in these times, and will be for several years more, to get linseed oil, let alone soya bean oil, and soya bean oil is higher in price than linseed. Linseed oil has been known for ages, and nothing has been found in all the substitutes that may be advertised and that may be tried, that will beat it. We are looking for something cheaper; not something more expensive.

"The addition of about six per cent of turpentine is recommended in nearly all cases to assist in penetration and to give the paint better spreading qualities." We use turpentine for two reasons: to make it spread on the bridge a trifle easier, in order to save a little labor, and to give penetration. I am now talking about repainting old steel or old structures where we have old coatings on. The only way to do this is to anchor your old coats. If you don't, you will have a separation, and trouble. The tur-

pentine is the material that penetrates into the old coating and forms a solid anchor, hooking up to the old coating that in some cases, no doubt, is hard and brittle. We even go sometimes to the use of benzol.

"The materials used on water tanks and coaling stations do not differ materially from those used on bridges." I expect this refers to steel tanks. Steel bridges and tanks are all subjected to the same climatic conditions, the same influences of air and moisture, and those are the two corrosive agents. What helps the one will help the other.

"No satisfactory results have been reported from the use of special coatings on coaling stations, ordinary bridge paint giving as much protection against the fumes of engines as any special preparation that has been tried." I believe I have tried almost every preparation that has been put out in this country and it didn't do any good. Our ordinary paint stands just as much as anything else.

"The question of painting galvanized iron brought out a great many formulas for washes to be applied to the iron before it is painted. These washes are supposed to prevent the paint from peeling, but none of them have any very enthusiastic advocates. The most successful method seems to be the weathering of the iron until the zinc coating is removed." When we talk about weathering we don't mean to let the iron go until holes are in it. The only thing we mean by that is to let nature do that which we might do in a quick operation by a coating to stop the action of the galvanization of the zinc which has been applied there. The white powder that you see on new galvanized iron will not bind to paint, and we will have peeling. You paint a sheet of galvanized iron with any kind of paint while the white deposit is on it and you will find that in six months it will open up and the first thing you know you can rip it all off, due to the fact that the zinc coating has stopped the combination between the iron or the steel and the coating. The most successful wash I have found is to dissolve about six ounces of copper acetate in one gallon of water; wash the galvanized sheet with it, let it dry, dust it off, and apply the paint, and you will have no trouble. That application removes the zinc film. But I wouldn't advise the use of it for it costs money to do that.

F. E. Weise:—When we were talking over the subject of painting in the executive committee meeting it was thought that

the association might be interested in getting the view-point of some outsider, and we invited Mr. Mowat of the Sherwin-Williams Company to come over and talk to us. He is obliged to be out of the city today, so he sent Mr. Swaney to read his paper for him. I would like to call on Mr. Swaney now.

Mr. Swaney:—I am sorry that Mr. Mowat couldn't be with you today, as he is very familiar with our manufacturing problem and possibly he could have given you the information that will be useful in a much better way than I can. I am on the sales end of it, and while I must know my products well and put them up to our customers, I am not as familiar with the manufacturing end as Mr. Mowat has been. I have often wondered why a body of men such as yourselves could not get together and possibly reach a conclusion upon what was the proper formula for a metal protective paint. As it is today you will find that one railroad has a specification calling for a certain percentage of pigments, while another road has another, and another road another. When we bid on those, in figuring our costs, we necessarily have to figure on a special product for each road, whereas if they were manufactured under a certain formula the manufacturer could have that standardized with him and he would have the material in stock. I would venture to say that today he could cut your cost of materials from 25 to 50 cents a gallon if there were standardized formulas.

(For Mr. Mowat's paper see Appendix " B," following report of committee.)

H. S. Bird—(By Letter):—Some of the parts of a bridge that are most susceptible to corrosion are the horizontal surfaces where exposed to the heat of the sun and the extreme cold and moisture of the winter storms. These parts are generally the first to show signs of corrosion. The tops of girders are extremely hard to protect. They should not pass with an ordinary painting, but should receive special attention. Very good results can be obtained by first applying one or two coats of paint in the usual way and then apply a coat of roofing cement or pitch. This will serve to resist the weather conditions and protect the under coatings. Bridge columns at street crossings are subject to abuse and corrosion on account of the acid conditions (uric acid). Good results can be obtained with similar treatment. After receiving a general painting, a coating of pitch or acid resisting paint should be applied.

THE ECONOMICAL USE AND STORAGE OF FUEL AT RAILWAY PUMPING STATIONS

Report of Committee

In the operation of railroad pumping stations the fuels commonly used are bituminous coal, gasoline, kerosene and fuel oils. As fuel is a most important factor in the expense of operation, it is obvious that, both in storage and consumption, it should be used economically. To effect this, machinery should be well maintained and the most efficient types of equipment utilized.

Storage capacity should be gaged with reference to requirements. To avoid undue deterioration, coal should not be stored to exceed 60 days. The storage supply should be located outside of and at a convenient distance from the pump house, away from other buildings and near an unloading track where one is available so that coal may be handled direct from the cars. To avoid the retention of some portion of the coal in the bin for an indefinite time there should be two openings to remove the coal. A bin may be constructed of second hand timbers or of other suitable material, with walls just high enough to contain the coal. Where not more than 60 days' supply is carried, a roof is not essential; as the economy to be derived therefrom will hardly be commensurate with the cost.

Where plants are located below tracks, chutes may be provided to convey the coal from the unloading track to the bin. At isolated plants and where it is necessary to deliver coal by teams, a covered bin with a suitable approach may be utilized and supplied by dump wagons, driven over or backed on to the top as the case may be, and the load dumped. The kind of coal used should be that which will show the most economy and must be determined by local conditions.

Steam, water and other wastes must be prevented. Pump houses should be built with a view to warmth. To minimize heat losses, boilers, steam pipes and the steam ends of pumps should be insulated where the saving will justify the expense.

The United States Fuel Administration has issued some valuable information in regard to economies to be effected through the proper maintenance and operation of steam power plants and the following is an extract from Engineering Bulletin No. 2, prepared by the Fuel Administration in collaboration with the Bureau of Mines. Acknowledgment is also given Bulletin 155, Department of the Interior, Bureau of Mines and Bulletin No. 8 of the Director General of Railroads, for much of the information contained in this report.

Stopping Fuel Waste

Beginning at the grates upon which the fuel bed rests, see that the air spaces are properly proportioned to avoid the loss of combustible material into the ash pit. This will depend on the kind of coal used. Study the fuel with this point in mind. Five per cent is not an unusual loss from this cause.

The amount of grate surface is important, as it determines the rate of combustion. Ratios of grate area to boiler heating surface will vary from 1:35 to 1:60, depending on the characteristics of the coal and whether hand fired or stoker fired. For power purposes in handfired plants do not permit the rate of combustion to fall below 15 lb. of coal per square foot of grate surface per hour, or go above 28 lb. with bituminous coal.

With settings tight to prevent the infiltration of air, heating surface

clean, radiation losses reduced by proper covering, piping and steam mains lagged, engine valves tight and properly set, all condensation returned to the feed-water heater a good start will have been made in fuel conservation.

However, merely placing the plant in good physical condition will not suffice. Conditions change from day to day, from hour to hour, even from moment to moment. These changes must be interpreted, and the degree of intelligence with which they are interpreted marks the degree of success which will be realized in fuel saving. A good plant poorly operated will show low efficiency, while a poor plant skillfully operated will sometimes show a relatively high efficiency. Therefore,

$$\begin{aligned} \text{Ultimate efficiency} &= \text{EXH} \\ \text{Where E} &= \text{Equipment} \\ \text{and H} &= \text{Human element.} \end{aligned}$$

Find out what the boilers are doing. Provide facilities for weighing the coal; for measuring the feed water; for checking up on combustion; for determining draft; for taking temperature readings at important points. To appreciate the significance of the above items it is desirable to become familiar with the literature of power-plant operation. Read Bulletin No. 1 of the United States Fuel Administration on Boiler and Furnace Testing, Technical Paper No. 80, and various other publications of the Bureau of Mines. In small and moderate sized plants, hand fired, a boiler efficiency of 60 to 70 can be expected. In any given plant determine what efficiency should be expected, considering load and equipment, and keep the plant up to the mark set.

The chief losses in boiler-plant operation are:

Cause.	Remedy.
1. Dirty boiler—loss up to 25 per cent,	Clean boiler
2. Leaky setting—loss up to 15 per cent,	Tight setting
3. Poor firing—loss up to 40 per cent,	Good firing

1. A boiler may be dirty on the inside or outside or both. Dirt on the inside is due to scale formation and can be corrected by cleaning the boiler and then giving consideration to the character of the feed water and its proper treatment. See Engineering Bulletin No. 3 of United States Fuel Administration.

Outside cleaning must receive careful attention. A slight accumulation of soot deposited in a few hours' run will result in a growing loss of efficiency. Some one must be delegated to follow up this matter of soot and see that the cleaning is done thoroughly, frequently, and regularly.

2. Air leaks reduce efficiency. The ordinary brickwork setting develops cracks and crevices which allow a considerable amount of air to enter the setting, lowering the temperature of the gases of combustion. The porous character of the brick itself is such that an appreciable leakage takes place through the walls.

The remedy is to paint up the brickwork with a plastic fireproof mixture and paint or cover the setting with a coat of air-tight material.

3. Bad firing includes allowing holes to develop in the fuel bed; carrying an uneven fire; carrying too thin or too thick a fire; stirring fire, thus forming clinkers; and improper manipulation of dampers. It is here that the human equation becomes of most importance. Attention concentrated on what takes place from day to day in front of the boilers will pay greater returns for the time spent than in any other part of the plant.

The Storage and Handling of Bituminous Coal

It is important, in order to prevent spontaneous ignition, that the following rules be complied with as far as practicable:

The storage ground should not be of a marshy nature or be subject to drainage from any source.

Coal should not be stored near external sources of heat, even though the heat transmitted be moderate, and should be located away from and not stored against buildings.

Avoid admission of air to the interior of the pile through interstices around foreign objects such as timbers or irregular brickwork or through porous bottoms, such as coarse cinders.

Do not permit pieces of wood, oily waste, or other easily combustible material to be mixed with coal during storage, as they may form a starting point for fire.

The height of piles should be limited to 12 ft. Arrange piles in as many units as possible, restricting the length and width as far as possible, in order to provide spacing, not only for ventilation purposes but to expedite rehandling if necessary, and limit the amount of coal in one pile subject to loss. There should be a distance of at least 5 ft. between piles, and this space maintained free for complete ventilation and dispersion of occluded gases.

Pile so that lump and fine coal are distributed as evenly as possible; not, as is often done, allowing lumps to roll down from the peak and form air passages at the bottom of the pile.

Where coal is stowed under shelter or inside of a structure, most perfect surface ventilation should be secured to facilitate the escape of gas by the circulation of the atmosphere.

In coal with a tendency toward heating temperature rises are comparatively gradual, and, if detected in time, complete combustion may be prevented by rehandling. If the ignition point is reached, fire may burn for a considerable time in the interior of a pile before becoming apparent. For the detection and prevention of fires, hollow iron pipes staggered every 50 ft. through the piles may be used, driven within 1 ft. or so of the bottom, these pipes being pointed and closed at the bottom to facilitate installation and provided with a stopper for closing the opening at the top, to prevent the admission of air; daily thermometer readings, or readings every few days should be taken in order that any excessive rise in temperature may be detected readily, and when the temperature has reached 125 deg. rehandling should be started. Coal of high sulphur content should be especially watched, owing to danger of "heating."

Wherever it is possible to do so, all wet coal, and especially that wetted by snow and ice, should be disposed of for immediate use without first being stowed; if, however, its stowage is unavoidable, it should form the top of the pile and be spread out as thinly as may be practicable to expedite drying by evaporation.

The only effectual way of extinguishing fire in coal storage is by rehandling. Water is not generally applied successfully in extinguishing a fire in a coal pile, because it is impossible to saturate the pile thoroughly; the best method of handling coal in danger of fire is to load it out and saturate it so that it will be cooled off thoroughly. The best preventive of loss in coal in coal storage is constant inspection for incipient heating and immediate removal of coal from the spot affected.

Oil Storage

Unlike coal, oil, if stored in closed tanks does not deteriorate when standing nor is it subject to spontaneous combustion; but the greatest care should be given to its storage, as oil and its vapors are very searching and extreme precautions are advisable, though with proper ventilation of the tanks the danger from fire is nil.

Weight for weight, oil can be stored in a smaller space than coal. One ton or 2,000 lbs. of bituminous steaming coal occupies approximately 40 cu. ft. according to A. H. Fay, mining engineer, Bureau of Mines, whereas a ton of oil occupies approximately 35 cu. ft. The relative storage value of coal as compared with oil is therefore 10 to 11.5.

A good steaming coal develops approximately 7,500 calories per

gram, according to A. C. Fieldner, chemist, Bureau of Mines. An average fuel oil develops approximatelv 10,500 calories. The relative calorific value, per unit weight, of coal as compared with oil is therefore approximately 10 to 14. For marine steam production, therefore, considering storage capacity, the relative value of coal to oil is 10 to 16.1, although the United States Navy gives a ratio even greater.

The relative efficiency of the steam engine compared with the heavy-oil internal-combustion engine is conservatively 10 to 25. Or, for marine service, the ratio of the total power of a heavy-oil internal-combustion engine for marine propulsion to that of a coal steam engine, considering fuel storage, calorific value of fuel, and engine efficiency, is approximately 10 to 40.25.

Steel tanks for the storage of oil may be secured in all sizes and in accordance with any particular specification, but it is more economical and satisfactory to have sizes and specifications conform to the gage and sizes of sheets commonly carried in stock by the manufacturers, as specifying tanks of special size causes waste through cutting sheets rolled to standard sizes and increases the cost of storage.

The following tables show tanks of various sizes with their capacities and weights that may be built from standard sheets without waste:

Standard Riveted Horizontal Cylindrical Tanks with Flat Heads and Shell of ¼-in. Metal

Capacity Gallons	Size Diam.	Size Length	Weight
4,000	8 ft.	10 ft. 9½ in.	4,500 lb.
5,000	8 ft.	13 ft. 6 in.	5,400 lb.
6,000	8 ft.	16 ft. ¾ in.	6,200 lb.
7,000	8 ft.	19 ft.	7,000 lb.
8,000	8 ft.	21 ft. 4 in.	7,700 lb.
9,000	8 ft.	24 ft.	8,500 lb.
10,000	8 ft.	26 ft. 7¼ in.	9,200 lb.
11,000	8 ft.	29 ft. 4 in.	10,000 lb.
12,000	8 ft.	31 ft. 10½ in.	10,800 lb.
13,000	8 ft.	34 ft. 8 in.	11,500 lb.
14,000	8 ft.	37 ft. 1¾ in.	12,300 lb.
15,000	8 ft.	40 ft.	13,300 lb.
16,000	8 ft.	42 ft. 6 in.	13,900 lb.
7,700	10 ft. 6 in.	11 ft. 11 in.	6,900 lb.
11,500	10 ft. 6 in.	17 ft. 9 in.	9,000 lb.
15,200	10 ft. 6 in.	23 ft. 7 in.	11,300 lb.
19,200	10 ft. 6 in.	29 ft. 5 in.	13,500 lb.
24,600	10 ft. 6 in.	38 ft. 1 in.	16,900 lb.
	Flat Heads, ¼ in.	Shell $\frac{3}{16}$ in.	
4,000	8 ft.	10 ft. 9½ in.	3,800 lb.
5,000	8 ft.	13 ft. 6 in.	4,400 lb.
6,000	8 ft.	16 ft. ¾ in.	5,000 lb.
7,000	8 ft.	19 ft.	5,700 lb.
8,000	8 ft.	21 ft. 4 in.	6,200 lb.
9,000	8 ft.	24 ft.	6,800 lb.
10,000	8 ft.	26 ft. 7¼ in.	7,300 lb.
11,000	8 ft.	29 ft. 4 in.	7,900 lb.
12,000	8 ft.	31 ft. 10½ in.	8,500 lb.
13,000	8 ft.	34 ft. 8 in.	9,100 lb.
14,000	8 ft.	37 ft. 1¾ in.	9,700 lb.
15,000	8 ft.	40 ft.	10,400 lb.

Flat Heads ¼ in. Shell 3/16 in.

16,000	8 ft.	42 ft. 6 in.	10,900 lb.

6,200	9 ft.	13 ft. ½ in.	5,000 lb.
9,300	9 ft.	19 ft. 5½ in.	6,500 lb.
12,300	9 ft.	25 ft. 10 in.	8,100 lb.
15,300	9 ft.	32 ft. 2¾ in.	9,700 lb.
18,200	9 ft.	38 ft. ½ in.	11,300 lb.

7,700	10 ft. 6 in.	11 ft. 11 in.	5,800 lb.
11,500	10 ft. 6 in.	17 ft. 9 in.	7,400 lb.
15,200	10 ft. 6 in.	23 ft. 7 in.	9,100 lb.
19,200	10 ft. 6 in.	29 ft. 5 in.	10,800 lb.
24,600	10 ft. 6 in.	38 ft. 1 in.	13,400 lb.

Standard Welded Horizontal Cylindrical Tanks of 3/16 in. Metal Throughout

550	4 ft.	6 ft.	800 lb.
1,000	5 ft. 5 in.	6 ft.	1,200 lb.
1,500	5 ft. 5 in.	9 ft.	1,600 lb.
2,000	5 ft. 5 in.	12 ft.	2,100 lb.
2,500	5 ft. 5 in.	15 ft.	2,600 lb.
3,000	5 ft. 5 in.	18 ft.	3,000 lb.

Standard Riveted Vertical Cylindrical Tanks with the Bottom and First Ring of 3/16 in. Metal and the Remainder Including the Roof of No. 10 Gage

6,000	10 ft. 6 in.	9 ft. 5 in.	4,100 lb.
9,000	10 ft. 6 in.	14 ft.	5,200 lb.
12,000	10 ft. 6 in.	18 ft. 4¾ in.	6,300 lb.
15,000	10 ft. 6 in.	22 ft. 10 in.	7,000 lb.

Partly or wholly burying oil tanks in the ground is a common practice. However, the ultimate economy is questionable, as the depreciation of the shell from soil corrosion may be rapid, and leaks, unless relatively large, are hard to detect and expensive to repair.

Concrete Tanks

In connection with the use of underground concrete tanks for the storage of oil it is interesting to note that the El Paso & Southwestern has been storing fuel oil of 24 deg. to 38 deg. B., in circular concrete tanks about 12 ft. in diameter by 6 ft. deep at various places along its system for the past five years. The bottoms of these tanks are 8 in. thick and the sides 6 in. thick, and each tank is covered by a concrete roof. The proportion of the mix is 1-2-4 and the largest rock 1 in. The aggregate is thoroughly mixed, and care is taken that when it is placed in the forms it is well tamped and all air bubbles thoroughly worked out so as to insure as dense a concrete as possible.

Tanks that have been in use five years have been examined inside and out but no signs of leakage were discovered. At present the company has 12 such tanks, and their adaptability to oil storage has proved so satisfactory that more are in process of construction. No oil or water proofing compounds are used.

A local electric company at St. Helena, Calif., built a rectangular reinforced concrete tank in 1911. This tank is 16 ft. long, 14 ft. wide and 5½ ft. deep, having a capacity of approximately 10,000 gallons. The bottom is 20 in. thick and the sides 8 in. at the bottom, tapering to 5 in. at the top. Both the sides and the bottom are reinforced with steel rods. At the time the tank was constructed it was coated inside with a solution of sodium silicate. However, after 18 months' service the coating had become practically useless. The tank at this time was examined

inside and outside by digging pits, but as no leakage was found no further attempt at oil proofing was made. Since that time the tank has been continually in service for the storage of oil varying in gravity from 15 deg. to 26 deg. B. The roof of this tank is made of wood covered with roofing paper. As a means of lessening evaporation losses and providing a run-off for rain water, as the wooden roof is practically flat, a second corrugated iron roof of proper pitch, has been constructed about 3 ft. above the first roof, allowing free circulation of air between the two.

Oil losses by seepage from properly constructed steel and concrete tanks can be considered practically negligible. The volume of useful hydrocarbon products lost through evaporation in oil storage is a considerable item, however, the loss, of course, being greater in the lighter oils than in the heavy oils, although there is a continued stream of the light hydrocarbons escaping from its surface as long as it remains in storage, even with oil of low gravity.

There are two general rules to follow to prevent evaporation losses: (1) to keep the temperature of the oil in the tank as low as possible, and (2) to make the containers as tight as practicable.

The color of the paint used on storage tanks is an important factor in preventing evaporation. It is reported that tests have demonstrated that evaporation from tanks painted white averages about 1 to 1½ per cent less than from tanks painted red, and about 2½ per cent less than from tanks painted black. These figures have not been verified, but tests made by the Institute of Industrial Research show that dark colored paints absorb heat to a considerable degree.

F. M. Case,
C. R. Knowles,
E. A. Demars,
Committee.

DISCUSSION

(Storage of Fuel at Pumping Stations)

J. B. White:—We have different ways of taking care of our coal but we have found the best so far is the open bin. We use probably from 160 to 200 tons of coal a month, and it doesn't stand very long before it is used.

The President:—What do you think of concrete tanks for the storage of oil?

J. B. White:—I have not given that any consideration. We don't use very much oil on our division, but I should think it would be a good idea. I would rather have them, I believe, than steel tanks.

C. R. Knowles:—Much has been said of late about the conservation of fuel and railroad properties are liberally placarded with instructions on the prevention of waste of coal in firing and through steam and air leaks, but unfortunately little, if anything, has been said about the waste of water and its effect upon fuel conservation. Every pound of coal used in our pumping stations goes to pump water and a fuel waste at the faucet is just as important as one between the coal bin and the stack.

The amount of coal required to pump a thousand gallons of water for general railroad purposes is, of course, a variable quantity as the water is delivered under varying heads and is handled by pumps with a wide variation in efficiency. It is also handled twice in many instances as in boiler washing and water softening plants. However, a conservative estimate of the average coal consumption per thousand gallons of water pumped is 25 lbs. On this basis the coal required to pump the water used by railroads is approximately 22,500,000,000 lbs. or 11,500,000 tons. The saving in fuel through the prevention of water waste would be 2,300,000 tons. To haul this coal unnecessarily consumed in pumping water to be wasted requires 57,500 cars of 40 tons capacity, or 1,150 coal trains of 50 cars each—more than three trains of coal per day every day in the year for no purpose other than to make up for gross carelessness in the use of water. There is an additional waste of fuel consumed in hauling this coal and in using cars that are badly needed for other purposes. Assuming that four days' time of each car is consumed in delivering the coal from the mine to the point of consumption and the value of the cars at $5 per day each, the total loss from this source alone is $1,150,000.

E. A. Demars:—Mr. Knowles' analysis is very thorough. It is the waste of the water more than the waste of the fuel at the pumping stations that creates the greatest cost. I have noted on many occasions where we could be very conservative with fuel, but due to the careless handling of the standpipes and tank spouts as much as a half tank of water has been wasted by the train men, so it would seem that more care should be taken in the handling of standpipes and tank spouts to prevent the waste of water.

L. A. Cowsert:—I want to mention the effect of stacks on the saving of fuel. There are many different opinions about the proper height of stacks for stationary boilers. I always like to use a stack not less than 30 ft. high for pump boilers, on account of different grades of coal we get in picking it up with the dirt and sand around the chutes.

C. R. Knowles:—I would like to ask if you don't find a large waste through having too much coal stored? Are there not times when you are forced to unload and take care of a lot of coal from coal chutes or a lot of screenings or other low grade coal that has to be disposed of?

A. S. Markley:—We store only about a car and a half or two cars of coal at a time, sometimes four. We use clam shells for unloading, which is more economical than unloading by hand.

A. W. Harlow:—The supervisor of locomotive operation on our road is a fanatic on the economical use of fuel. He watches the stacks of the pump house boilers, as well as the locomotives. We fire our boilers a shovel full at a time, instead of filling them up and shooting out a lot of black smoke. I believe that the firing of the boilers is one of the points that we ought to consider in the economical use of fuel. Some people say that it takes black smoke to make steam, but it doesn't, for you can fire a boiler without black smoke. We generally start out with a work train and a locomotive crane, and unload our winter's supply in the fall. We have no particular storage bins for pumping stations. Then in the summer we handle a car load at a time.

Jas. Dupree:—There is another large factor in fuel conservation—the waste of water. It is not only wasted from standpipes, but also at hydrants at cinder pits, the little pipes in the roundhouses, etc. I think the waste of water is a larger factor than the waste of fuel, because the man that pumps the water is not going to shovel any more coal than he has to in order to keep up steam.

E. A. Demars:—I presume the largest waste at pumping stations results from storing too much coal, especially if the quality of the coal is very soft. Very soft coal deteriorates rapidly. I have known several occasions where it was necessary for the pumpers to screen this soft fine coal and they threw out all the coal that went through the screen, along with the ashes, and as much as a half carload of coal has been thrown out with the ashes at a time, owing to its soft quality and deterioration.

Another condition that exists at pump stations which should be watched carefully is the condition of the grates. If the pumper permits his grates to burn out and get cracked and loose, sometimes as much as 25 or 50 per cent of the coal that he puts into the fire box goes into the pit unburned. I have seen where tie plates and pieces of iron pipes were put in boilers in holes where the grates had been burned out, to keep the coal from dropping through.

G. W. Rear:—There is another waste that no one has spoken of; that is the waste from the theft of coal around the pumping stations. I know, to my positive knowledge, of four pumping

stations in Eastern States that supply their whole neighborhoods with coal. I believe that the conservation of fuel can be promoted to a considerable extent by keeping the coal locked up; also by a little judicious sleuthing now and then to see whether the coal is actually being burned under the boilers.

J. S. Robinson:—At the water stations we have small platforms or bins into which we put a car of coal at a time. The time of the local freight, or of a special train to unload the coal at different stations ($105 a day for a work train), amounts to a good deal in the cost of the coal, and I think we ought to consider that. It would be a great deal better to line your coal bin with old boiler plates or anything you can get, or even build a concrete bin that will hold five or six car loads at a time so you would have a winter's supply.

Jas. Dupree:—Since a cost of $105 a day for a train adds much to the cost of the coal, wouldn't it be cheaper to put in a spur track at the place? A switch costs about $100. To be sure, you may have the switch on a high speed track, which is dangerous, but I think it would be cheaper to put in a spur track and set the coal near the pumping station and let the men unload it at their leisure.

E. T. Howson:—I ran across a manner of unloading coal two or three years ago which is applicable to certain stations. That is the use of the ordinary dump car, loading coal at those points where it can be loaded conveniently, the way-freight taking it out, dumping it quickly and going on. Where the storage is below the tracks the coal can be dumped onto an inclined platform.

Another thought occurred to me in the consideration of the economical use of fuel, which has been touched on in previous reports before this association. That is, when the time comes for a selection of pumping plants, the consideration of the economical fuel. Once the plant is installed you can't change from oil to coal or the reverse, but before it is installed, when the consideration of the fuel question is brought up, that opportunity is presented. The fuel situation has changed so rapidly in the last few years that previous estimates of economies must be revised on the basis of present information. The use of fuel oil has been discontinued in certain parts of the country, but in many other parts of the country it is expanding. My attention was called yesterday to two large railroads that have just con-

tracted for a two years' supply of fuel oil for divisions comprising several hundred miles, on which coal had been used, but on which fuel oil is now to be used, just an instance of changing conditions which have made fuel oil more economical than the coal. In other places the reverse is true. There are times when we can switch from one fuel to the other with considerable economy.

A. S. Markley:—A great mistake is made in many instances in having too small machinery. I have in mind a place where we have a small pump that pumps from six to seven hours a day to get the supply of water. We installed larger equipment and the pumper now fills his tank in two hours with 50 per cent less consumption of fuel.

Speaking about the theft of coal at night, we tallied up the consumption of coal for a year, when the coal was lying outside, and then we put it into a coal house under lock and key, and we saved 30 per cent of the coal that year.

W. J. O'Brien:—I wonder what success others may be having in furnishing warm water to the boiler feed in rural districts. We tried it on our road with good results.

C. R. Knowles:—I guess some of the older members know my attitude toward the use of locomotive boilers in pumping stations. If anyone gives me an old second hand locomotive boiler in pumping stations for use in pumping water, he is not interested in fuel conservation. If we are going to save fuel, and if we are going to effect further economies, scrap the old locomotive boiler, because it is nothing but a fuel waster. As far as the use of boiler feed water heaters is concerned, I think they are coming into more general use, especially at the larger pumping stations. Many of the Eastern railroads have used boiler feed water units for a number of years, and I notice them coming into pretty general use on the Western roads also. The Eastern roads use them primarily at the larger stations where they have track pans. Of course they require quite a large power plant and considerable heating apparatus, but there are quite a number of them going in on Western roads, particularly since the smaller sizes of feed water heaters have been made more efficient.

Jas. Dupree:—Mr. Knowles' point is well taken. It is a fact that a locomotive boiler is the poorest thing in existence for a stationary boiler. The flues are too small. I would suggest

throwing them into the scrap heap—the sooner the better. It will be money saved if you get rid of them. Flues should be of a large size, with plenty of room from the hand plates and over the top of the boiler; big hand plates so they can get everything out and clean out thoroughly, if you are going to conserve fuel, and that is what we are working on at the present time.

J. T. Andrews—(B. & O., By Letter):—I note that this report seems to apply very largely to large stations or power plants and not to small type stations, such as the majority of railway water stations are. This applies particularly to the discussion in reference to stopping fuel waste.

While the points noted are undoubtedly correct, I believe that the conditions existing at most of our pumping stations call for education of the human element, rather than the installation of highly efficient equipment. I doubt if it is very practicable to make any large expenditures for boiler lagging and pipe covering at such stations, as the initial cost and maintenance would probably overshadow the benefits to be derived. Good firing is the most important point. I believe that a proper course of instruction of the pumpers would accomplish better results than anything else.

As to some stations where we have larger boilers, it would probably pay to install small feed water heaters, it being a well known fact that a very material saving can be made in fuel with any material increase in the temperature of the boiler feed water. The cost of such a device would not be very heavy. Another inexpensive attachment which is lacking at most of our small water and power stations, is a damper on the smoke stack, and it would pay to install them, provided the pumpers were properly instructed as to their use.

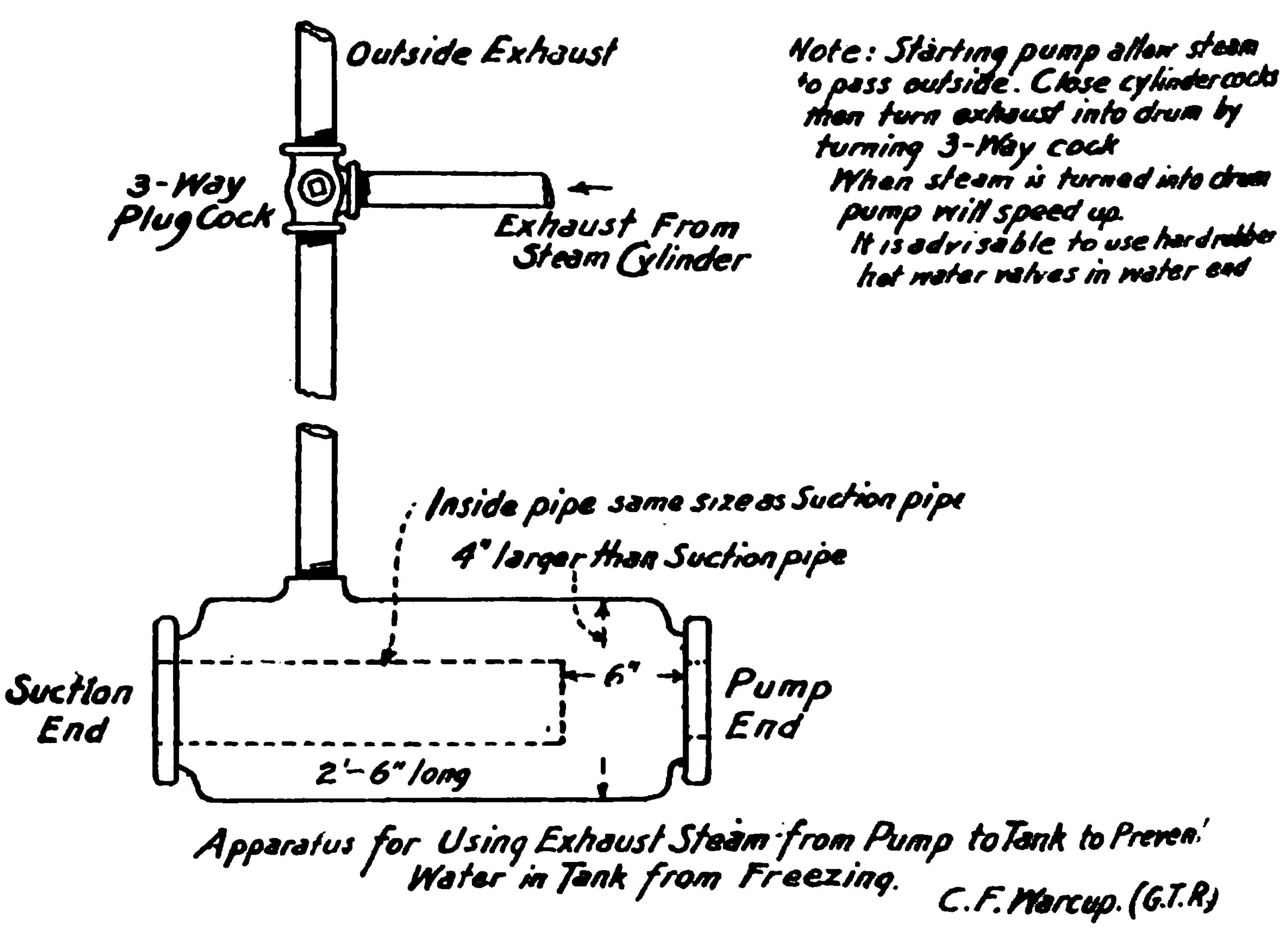
With regard to the storage of coal; the report applies almost entirely to large power plants. At the usual water station, I believe that we can best fulfill the requirements by having a clean and tight bin, free from obstructions and capable of holding not less than one month's and not more than two months' supply. Delivery should be made from a trestle wherever it is possible to do so, in order to save labor of handling.

Regarding oil storage; the tanks should be of sufficient size to hold a tank carload in order to take advantage of the lower prices at which oil is usually obtained in such lots. I note that the report is not in favor of burying the tanks, but I believe that

this should be done, as it will result in keeping the fuel at a lower and more even temperature. I also note some remarks as to the effect of the color of paint upon evaporation and believe that this is a very interesting point which should be developed further. I believe that concrete tanks will probably be preferable for oil storage, both on account of the cost and the possibility of burying them without the disadvantages mentioned, if this was done with steel tanks.

No mention is made as to the storage of gasoline and kerosene, but I consider that this can be best taken care of by the use of comparatively small tanks, holding from 250 to 500 gal. If tanks of larger capacity are used, the evaporation losses with both classes of fuel will probably be very heavy.

A point which is to be considered, is that in handling any of the classes of liquid fuel a proper pump should be provided which will reduce the manual handling to a minimum in order to avoid waste.



Apparatus for Using Exhaust Steam from Pump to Tank to Prevent Water in Tank from Freezing. C. F. Warcup. (G.T.R.)

RAILWAY FIRE PROTECTION EQUIPMENT

By C. R. Knowles
Superintendent Water Service, Illinois Central Railroad

The subject of fire-extinguishing apparatus is necessarily one of great detail and brings out the study of the extent and character of the properties, the natural conditions surrounding them, and their use and occupancy. The class of appliances will necessarily cover a wide range, starting, however, with the idea of having an ample supply of water to meet the maximum conditions that may arise. Careful study is necessary to determine the specific character of the fire-extinguishing devices required to meet the demands of each class of property. These include the use of water mains and fire-hydrant systems under ample volume and pressure from public or private reservoir or other source of supply, with incidental fire pumps, elevated tanks, standpipes, fire hose, fire extinguishers, steam jets, sand pails, water barrels and pails; all of which must be studied and installed with due regard to their relative values. An important fire-fighting agency on railroad properties is the locomotive or yard engine used at terminals and large yards remote from public protection, so equipped for supplying water under pressure with the aid of fire hose as to give good service in the event of fires in rolling equipment and its lading.

The five principal fire extinguishing agents in use on railroads are as follows:

Bicarbonate of Soda,
Caustic Soda and Sulphuric Acid,
Carbon-tetrachloride,
Dry Sand,
Water.

The class of appliance or equipment for handling the above agents properly will necessarily cover a wide range, and it is not the intent of this paper to discuss the various appliances in detail as a careful study of the extent and character of the property is necessary to determine the type of fire extinguishing equipment best suited to meet local conditions and the demands of each class of property.

Where definite recommendations are made they are in accord with the requirements of the National Board of Fire Underwriters and instructions given in Bulletin No. 8, "Manual on Fire Protection for Railroad Properties," issued by the Director General of Railroads in 1919. Acknowledgment is given to this bulletin for much of the material contained in this paper.

The various extinguishing agents given above and the equipment for their proper handling will be discussed briefly in the order given.

Bicarbonate of Soda

This is nothing more than common baking soda and is usually contained in tin tubes; it is useful only in incipient fires and is of but little value as a fire extinguisher. The use of dry powder extinguishers of this type should be discontinued as too much reliance may be placed upon them, thus delaying the use of other more efficient extinguishing agents.

Caustic Soda and Sulphuric Acid

Chemical fire extinguishers using soda and acid are usually furnished in the 2½-gal. hand type and in the 40-gal. type mounted on wheels. The hand type is one of the best fire extinguishers known for small

incipient fires. As many of them are located at points where there is no other fire protection it is important that they be kept in perfect order at all times. They should be discharged, cleaned and recharged at least once each year, the date of recharging to be marked on the tag attached to the extinguisher. At least two extra charges should be on hand for each extinguisher.

The care of extinguishers should be assigned to some particular man at each point as a division of responsibility for their condition will lead to neglect. They should be inspected weekly; this inspection should include a careful examination of the nozzle, hose and hose connection and the renewal of defective parts as soon as discovered. Instructions as to the recharging and care of these extinguishers should be carried out rigidly as efficient operation depends upon instructions being followed explicitly.

Extinguishers of this type should not be exposed to freezing temperature, if it is possible to avoid it, and should be accessible at all times. Hand extinguishers should be hung in accessible places with their tops not more than six feet from the floor. Only those approved by the National Board of Fire Underwriters should be used as others are dangerous and their use may result in injury to the operator unless they have been properly tested out.

Carbon-tetrachloride

This liquid is particularly effective on fires in hazardous liquids, other rapidly burning materials, electrical fires and other fires not readily extinguished by water. The extinguisher for using this liquid is usually of the one-quart pump type and, on account of the small size, is of value only in incipient and small fires. The freezing point of carbon-tetrachloride is 25 to 50 deg. below zero, therefore, it is very desirable where low temperatures prevail. These extinguishers should receive the same care as other chemical extinguishers and should be kept full of liquid at all times. A reserve supply of liquid for refilling should also be available.

Sand

Sand is useful chiefly in oil fires and should be contained in pails or properly constructed sand boxes with scoops for throwing. The sand should be clean and dry and the supply should be located near a doorway in order that it may be accessible. The boxes or pails containing the sand should preferably be above the floor to keep the sand free from dirt and moisture.

Water

Water is, of course, the principal agent used in fighting fire, all other agents being of value chiefly on incipient fires, or in chemical, oil and electrical fires which are usually limited in extent. Therefore, from whatever source water is obtained for fire purposes, the supply should be ample and constant. This is the first requisite. Second only to an ample supply of water is the importance of adequate facilities, properly constructed and so located as to permit fighting the fire with a minimum of delay.

Fire Pumps

The fire underwriters have laid down extensive rules and regulations governing the design, location, maintenance and operation of pumps used for fire purposes. These rules are so well known and easily obtained that it is hardly necessary to quote them here.

Unfortunately there are but few pumps used exclusively for fire protection on railroads, the average pump being designed and used primarily for general service pressure. Fire protection being incidental, therefore, it is impractical to apply these regulations to all pumps without impairing the service for which they are primarily designed.

It is sufficient to say that where service pumps are also used for fire protection their operation should conform as closely as possible to the rules laid down for fire pumps. All connections between service and fire lines should be equipped with proper valves, plainly marked and their use fully understood by all concerned.

Pipe Lines

Pipe lines serving fire hydrants and fire connections should be independent of general service where possible, but if a part of the general service system they should be so constructed and arranged that service connections can be cut off and full fire pressure maintained on hydrants and hose connections. Underground lines should be of cast iron, laid in complete circuits or gridironed when practical to do so, and should be not less than six inches in diameter except where extensions are being made to existing lines of smaller diameter. They should be laid to a sufficient depth to prevent freezing and should not be run under buildings.

Valves

Post indicator valves should be used to control all underground fire mains wherever possible. If post indicator stands are not practical for any reason, valves should be located in valve pits and their location and purpose plainly indicated by signs. Where fire mains are connected direct to general service lines a check valve should be placed so that it will close automatically when fire pressure is applied or a post indicator valve installed and its purpose fully understood.

Hydrants

Fire hydrants should be of an accepted type offering the lowest resistance to the flow of water. Ground or outside hydrants should be of the two-way type and should be designed to drain automatically when the valve is closed, to prevent freezing. It is very desirable that the outlets be fitted with independent hose valves. All outlets from ground hydrants should be 2½-in. openings. Threads on hydrant connections should fit the connections on public fire department hose. Hydrants should be located far enough from buildings to prevent them being inaccessible during a fire, or from being put out of service from falling walls; 50 to 75 ft. is usually the proper distance. They should be painted white so they may be located readily at night. They should be inspected frequently to see that they are in proper condition and that they drain properly to prevent freezing. Under no circumstances should fire hydrants be used for other than fire purposes. Hydrant wrenches and spanner wrenches for tightening hose should be located conveniently and in sufficient number to provide at least one for each hydrant.

Water Barrels and Buckets

Number recommended:

In passenger stations, three pails for buildings of ordinary size, increasing the number by one pail for about each 500 sq. ft. of floor space over the first 2,000 sq. ft.

In freight stations at least one barrel and two pails for buildings of ordinary size; increasing the number in larger buildings by one barrel and two pails for each additional 3,000 sq. ft. of floor space over the first 3,000 sq. ft., so as to make them readily accessible to all parts.

In combined passenger and freight stations, one barrel and two fire pails to be placed in the freight room, increasing the number in larger buildings as indicated for freight stations.

In shop buildings, one barrel and two pails to be distributed for about each 3,000 sq. ft. of floor space.

In warehouses, two pails for a floor space of 1,000 sq. ft. or less, increasing the number by one pail for each additional 500 sq. ft.

In other and miscellaneous property as conditions may require and permit.

Barrels to have a capacity of not less than 50 gal.

Freezing

When fire barrels and pails are located where there is a liability of the water being frozen in cold weather, it is recommended that chloride of calcium or salt be placed in each to retard freezing. The density of the solution required will depend upon existing temperatures. The following tables have been suggested as appropriate mixtures for the solution:

Commercial calcium chloride

Lbs. per Gal.	Freezing point Deg. F.
½	29 above zero
1	27 above zero
1¼	25 above zero
1½	23 above zero
1¾	21 above zero
2	18 above zero
2¼	14 above zero
2½	8 above zero
3	zero
3½	6 below zero
4	17 below zero
4½	27 below zero
5	39 below zero
5½	54 below zero

Common salt (sodium chloride)

Lbs. per Gal.	Freezing point Deg. F.
½	24 above zero
1	18 above zero
1¼	15 above zero
1½	12 above zero
1¾	9 above zero
2	6 above zero
2¼	3 above zero
2½	1 above zero
3	3 below zero
3½	8 below zero

The solution should preferably be mixed in a vat before being placed in barrels, care being exercised to see that the salt is entirely dissolved. If dumped into a barrel and covered with water, or if thrown into a barrel of water, the salt will be only partially dissolved and unsatisfactory results will be obtained. It is necessary that the chloride of calcium or the salt be dissolved by thorough stirring.

Calcium chloride is possibly superior to salt in the following respects: it does not corrode steel tanks and barrel hoops readily; it has no odor and will remain odorless even if left standing for a long time, and its affinity for moisture prevents evaporation of the water. Where calcium chloride solution is used, wooden barrels should first be well coated inside with asphaltum, or with a mixture of crude paraffin and resin to prevent shrinking of staves and consequent leakage.

Fire Hose

Fire hose is one of the most important of fire-extinguishing agencies, and, as with all fire-extinguishing apparatus, to be reliable it should be of the best material and workmanship. It should always be in perfect working order and at all times properly cared for.

Fire hose is subjected to a severe class of service, the importance of which makes it essential that the utmost care be given to the quality of the materials and the character of the workmanship employed in its manufacture.

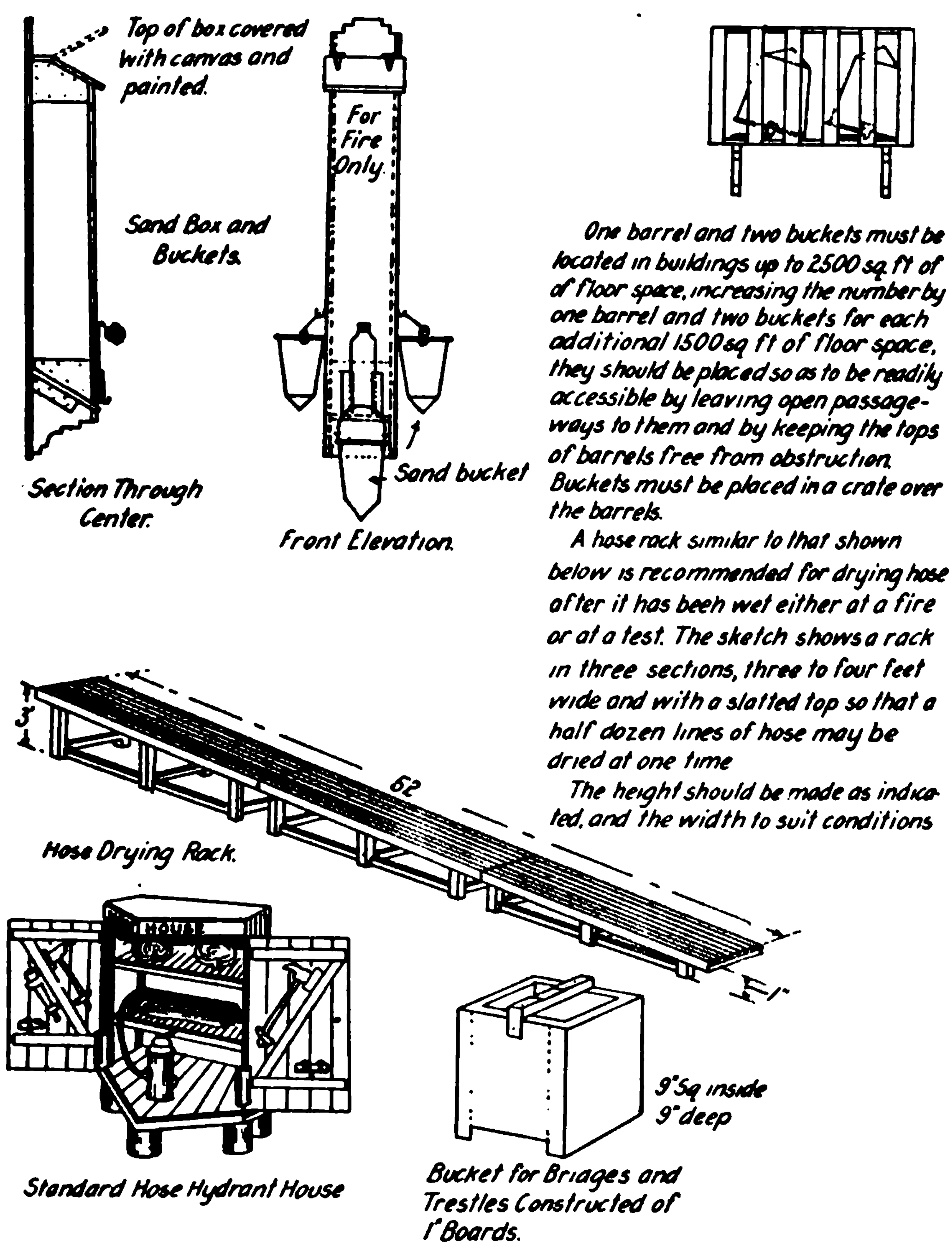
By purchasing only the best hose and giving it the small amount of attention suggested, the greatest practicable durability will be assured.

Experience has shown that a good cotton rubber-lined hose, properly cared for, will frequently last 10 or 15 years.

Cotton Rubber-lined Hose

For use on the yard hydrants of shops, mills, terminals or other property and for the interior of large stations, warehouses, piers, shops,

etc., a single "jacketed" or "ply" cotton rubber-lined hose is suitable for ordinary pressures and is recommended. For many yards and buildings it is preferable to the thicker and heavier jacketed hose, as it is easier to handle, more quickly dried and more economical. For yards or buildings where hose will receive rough handling or be liable to heavier wear and pressures, the same quality of hose is recommended with additional jackets, separate or interwoven, composed of the same kind of cotton fabric. The light grades of fire hose on the market, generally known as "mill hose," are too light and generally of too low grade for the best service in shops, and terminals, and are not recommended.



For use on yard hydrants, no hose smaller in inside diameter than 2½ in. should be used. The loss of pressure is three times as great in 2-in. hose as in 2½-in. hose, and, although where a line of only 50 ft. is used the effect of friction is not much, for longer lines it is a serious detriment.

Unlined Linen Hose

For fire hose to hang up in exceptionally dry, warm rooms, corridors or office buildings, hotels, etc., unlined linen hose is suitable and is recommended. Specifications are also prepared for its manufacture, and

purchasers should be assured that hose of this class meets the requirements of the "National Standard." Its chief value is for short lines for brief use inside some classes of buildings where it is best on account of its lightness, compactness, and convenience for use by one man alone.

Two and one-half inch hose is the standard size used for attachment to standpipes inside buildings, depending upon the water supply, although 1¼-in. and 1½-in. hose are lighter and more easily handled, and may be used. The durability depends upon the preliminary preparation and spinning of the fabric; and hose manufactured in accordance with the special specifications for this class of hose is therefore necessary, that it may hold water and stand a high pressure.

Linen hose is injured every time it becomes wet, but if kept in a dry place, it may continue a reliable safeguard for 20 years or more. It is not suitable for lines of more than 50 or 100 ft. in length because of the loss of pressure due to friction caused by its interior roughness; and it is not suitable for outside use, because holes chafe through it quickly under the pulsations of a pump or when laid over sharp stones, cinders, material, or around sharp corners.

It will be seen that only under exceptional conditions is linen hose recommended, on account of the inability to test it or the water facilities, where used.

Care of Cotton Rubber-lined Hose

Owners of hose and those responsible for its care are cautioned and urged (1) to run water through it occasionally (at least four times a year) as it keeps the rubber in good condition and lengthens its life; but to drain the hose and allow the cotton fabric to become thoroughly dry before stowing away again. (2) To test it about once a year to about 500-lbs. pressure to make sure it is in good condition. If put on a cart and allowed to remain after use, wet hose is liable to become damaged quickly. For this reason it should be removed from the cart as soon as it is returned to the hose house, and dry hose substituted. In making this change, the requisite number of lengths of dry hose should be gotten ready, the couplings and washers examined, and the threads treated with a little tallow or mineral oil. The wet hose should be unreeled in sections and the dry hose reeled on. The wet hose should be hung up in a tower or laid on racks to dry. If the hose is dirty, it should be brushed off with a broom after drying. If a drying tower is not practicable, a slanting ventilated hose-drying rack is recommended as a simple and effective arrangement to be used for drying hose after it has been wet, either at a fire or at a test. The rack should be 52 ft. long, 4 ft. or more wide, 1 ft. high at the lower end and at least 3 ft. high at the upper end, and with slatted top, and may be built in sections to facilitate moving. The rack facilitates the proper care of the hose, which will tend to prolong its life and thus reduce the cost of a perishable part of the equipment.

(3) Keep the hose valves tight so that hose will not be wet by leakage. Where cotton rubber-lined hose is attached to standpipes on the interior of large stations, warehouses, piers, shops, etc., in order to prevent leakage entering the hose at hose connections, place a ¼-in. drip cock in the body of valve or a fitting with a drip cock as near the valve as possible, leaving it open to drain away leakage.

(4) To avoid keeping hose in warm rooms, but preferably in a small, well ventilated hose house.

(5) To roll up or stretch out all stock hose, as far as possible, to prevent sharp bends or kinks in it which may injure both fabric and lining.

Care of Unlined Linen Hose

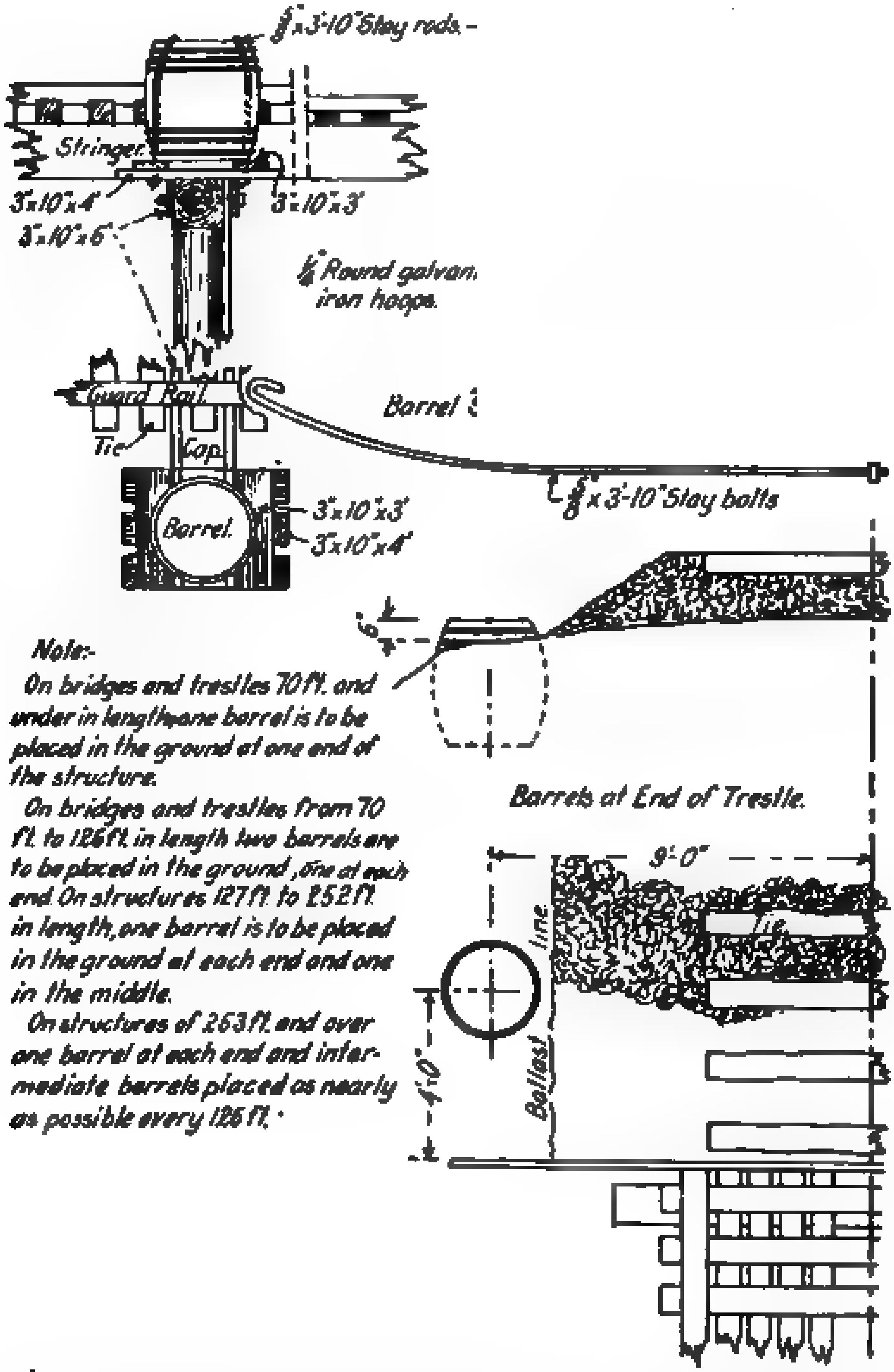
Never wet unlined linen hose except to use at a fire.

Keep the hose valves tight so that it will not be wet by leakage.

This is the most common cause of injury to hose of this kind. Use a well-made brass-bodied gate valve.

To prevent leakage entering the hose at hose connections, place a ¼-in. drip cock in body of valve or a fitting with drip cock as near valve as possible, leaving it open to drain away leakage.

Stretch the hose out from time to time, that it may be dried between the layers. Racks for linen hose should allow it to hang vertically, as this gives better ventilation than if folds are laid horizontally.



The necessity for uniformity in the size and screw threads of hose couplings throughout the country has often been strongly emphasized, as is the case when one neighborhood is likely to call upon another, in the event of a serious fire. A "National Standard" for size and thread of hose couplings and hydrant fittings has been considered and has been

adopted by many associations of national influence in matters regarding fire protection and extinguishment. Particular attention is called in this direction to owners or operators of shops and other large properties to see that their fire hose and fire hydrant couplings conform to the National Standard threads wherever possible (2½ in. by 3$\frac{1}{16}$ in., 7½ threads to the inch), but that they are uniform with those of the nearest municipality, so that when the city fire department is called upon, the hose connections may be of service. Where couplings are not uniform, adapters should be provided.

Rigid and systematic inspection of all fire apparatus should be made by specially-delegated employees, preferably members of fire brigades, at least once a week; everything down to the smallest piece of apparatus should be in its place and in good order ready for use, and a report of such inspection should be made to those in authority.

Hose Reel and Hose Rack Specifications

No. 7, Wirt's swinging wall reel for 100 ft. of 2½ in. cotton rubber-lined hose.

No. 4, Wirt's swinging wall reel for 50 ft. of 2½ in. cotton rubber-lined hose.

No. 5, Wirt's swinging wall reel for 100 ft. of 1½ in. cotton rubber-lined hose.

No. 2, Wirt's swinging wall reel for 50 ft. of 1½ in. cotton rubber-lined hose.

(Cotton rubber-lined hose to be used where exposed to moisture and rough usage.)

No. 18X, Wirt & Knox Royal hose rack for 25 ft. to 75 ft. of 1½ in. unlined linen hose.

No. 18Y, Wirt & Knox Royal hose rack for 25 ft. to 75 ft. of 2 in. unlined linen hose.

No. 19X, Wirt & Knox Royal hose rack for 100 ft. to 150 ft. of 1½ in. unlined linen hose.

No. 19Y, Wirt & Knox Royal hose rack for 100-ft. to 150 ft. of 2 in. unlined linen hose.

(Underwriter's unlined linen hose to be used in office and other buildings where not subject to test nor exposed to injury or dampness and on switch engines.)

Hose Cart and Nozzle Specifications

Shop Plant Hose Carts

Wirt & Knox hose cart No. 55, figure 750 with 50 ft. of drag rope, rope reel, two pipe holders, tool box, wrenches, etc., wheels 52 in. dia., wrought frame, steel axle, hose roller in rear. Net weight, 220 lbs. Capacity 500 ft. of 2½ in. C. R. L. hose.

Warehouse Hose Cart

Wirt & Knox Fire Jumper No. 4½, Style I-X pipe holder, tool box, wrenches, etc., axe in spring holder, wheels 48 in. dia., hose roller in rear. Weight 250 lbs. Capacity 400 ft. of 2½ in. C. R. L. hose.

Fire Hose Nozzles

Underwriter's Play Pipe 2½ in. by 30 in. long. Orifice 1⅛ in., screw nozzle wound and painted with metal swivel handle, smooth bore.

Note: This type nozzle to be used on 2½ in. C. R. L. hose outside of buildings. Two underwriter's play pipes to be on each hose cart. C. I. play pipe with brass hose threads, aluminum bronzed 2½ in. by 12 in. long to be used on 2½ in. C. R. L. hose in buildings. C. I. nozzle with brass hose threads, aluminum bronzed 1½ in. by 12 in. long to be used on 1½ in. C. R. L. hose or unlined linen hose.

DISCUSSION

(Railway Fire Protection Equipment)

C. W. Wright:—There is such a small amount of unlined linen hose used on railroads that I don't like to see that reference to it go in as a recommendation of this association or even reference to the fact that there is such a thing as unlined linen hose, as far as railroad fire protection is concerned. It is only in our office buildings that we can use it and not have it abused, and even there it is sometimes abused, for I have seen unlined linen hose reeled out on the floor for scrubbing purposes. Further, I think if we will go on record as saying that any employee using fire apparatus, no matter what it may be, extinguisher, barrels, or hose equipment, and not making an immediate report of it, is subject to discharge without further trial, we will get along a great deal better. It may be a serious matter if an extinguisher or a fire hose has been used, and the couplings marred and not reported to the man who takes care of that equipment so it can be put into proper shape again. We would certainly discharge a man for not making an immediate report. The matter of fire pails for use around stations and warehouses is another serious matter. We have developed a conical shaped pail that we make ourselves, in which we have left a little hole less than a quarter of an inch in diameter in the point of the cone so that it cannot be used for any other purpose. We have demonstrated that a man can stand at a barrel and empty the barrel quicker with that pail than he can with any other, for the water is released without any back-draft. You can put a 50 gal. barrel of water in exactly the place that you want it in an incredibly short space of time. We have received the approval of the insurance department of the Pennsylvania Railroad on it, and I don't believe that the National Board of Fire Underwriters is any harder to satisfy than is that insurance department. There has been great activity during the war period to cause the railroads in the eastern districts to equip with automatic sprinklers. We have opposed them on our piers, particularly, not on the ground that we want to have anything less than the greatest amount of protection possible, but from the fact that piers are subject to considerable vibration, and it is hardly possible to keep a sprinkler system in such condition that it can be depended upon at all times on railroad piers. I believe we would be justified in making an adverse

recommendation on sprinkler systems on piers, particularly of lighter construction, with wood piles, etc.

C. R. Knowles:—Mr. Wright's reference to the abuse of unlined linen hose in offices, is probably well founded, but it is not the province of this paper, or of this association, as I see it, to recommend any particular class of hose. Most of us are guided entirely by the ruling of the National Board of Underwriters, and in many cases by our own supervisors and fire forces. The aim and intent of this paper was to suggest the care of railway fire protection equipment, because we realized that we have little to do with the making of the standards, and that we should be interested primarily in taking care of it. Mr. Wright says that railroad fire protection equipment is abused. It is not abused, however, by the maintenance forces, because it is their duty to prevent that abuse as much as posible, and any rules or disciplinary measures intending to enforce the proper care of fire protection equipment would have to come from other departments, so that we really would have no voice in the matter.

The Chairman:—While we are not going to make any definite recommendations in these matters, the fact that Mr. Wright brought up this matter and Mr. Knowles' paper on it, are in the record as valuable information.

A. S. Markley:—How do they handle the water to prevent it from freezing in a sprinkler system in cold weather when there is no fire?

C. R. Knowles:—That is used with a dry pipe system. Nearly all of our coal chutes are equipped with sprinkler systems,—what is known as the "Dry Pipe System,"—the Grinnell pipe valve, in which an air pressure is maintained throughout the system above the valve. That pressure is usually about 30 or 40 lb. and remains on top of the valve. The air jet is of much larger area than the water jet; consequently a lower pressure is required on top to overcome the higher pressure below. The result is that as soon as the sprinkler head is opened from fire or any other cause that releases, causing the valve to open, the system fills with water.

A. S. Markley:—Where the pipes are without water there is an accumulation of rust inside that will close the outlets and also the dead ends.

C. R. Knowles:—The National Railroad Fire Protection Association has published some data on the operation of sprinkler systems at, I don't recall the number, but it seems to me it was on

some 16,000 fires, in which the percentage of failure of the sprinkler system was almost negligible.

G. W. Rear:—In the cut showing the water barrel on the trestle, in the report, I want the privilege of submitting an alternate cut for the proceedings. We carried the water barrel on the end of the cap as shown there for many years, but we found on a higher trestle that the barrel was of practically no use to anyone except the bridge man, as an ordinary traveler or neighbor who happened to see a bridge on fire wouldn't take the risk to get out on the bridge and try to get the water out of the barrel. We, therefore, made platforms for the water barrels by extending the ties out far enough to set the barrel up on the deck. These platforms afford a good refuge for anyone who happens on the trestle when a train comes along. We have found them very satisfactory, and we are trying to install them on all our trestles now.

A. S. Markley:—We are trying to furnish dry sand to put out fires on treated timber, treated ties, etc., as we have heard that the more water you put on, the worse it makes the fire. Have you made any provision for that?

C. R. Knowles:—The paper treats with various fire fighting agents, carbon-tetrachloride, dry sand, etc. Dry sand would easily be effective in fires of that kind, which would be classed, I believe, among oil fires. With regard to barrels on trestles the plan shown is simply a general scheme for making the barrel fast. I don't see any objection to fastening it on long ties, or in any other manner in which you might wish to fasten it to the trestle. The fastening, clamp, etc., and the platform would be similar in any case, whether you placed the barrel on a level with the ties or below, as in this case, where it is on the caps. This is not a standard. It is merely one method, and I suppose one will find a dozen different methods on various railroads.

E. K. Barrett:—I have just put in a few docks at Jacksonville, building them with creosoting material. Not having any experience in handling fires in this material, I took the question up with the cresoting plant at Jacksonville, to find out whether water was a good thing to use in fighting fire in cresoting material as I had been advised that the application of water created gas and made the fire burn worse. I was advised that as far as their experience was concerned, water was all right for fighting creosote fires, as they had had a good many fires around their plants, on vessels, tow boats.

etc., and they had always been able to control them satisfactorily with water.

G. W. Rear:—A fire in creosoted material can be fought with water as well as any other fire but a fire in creosote oil itself cannot be fought with water. If the oil should happen to get out on the floor through a leak or break in a tank, it would be unfortunate to try to fight it with water.

A. S. Markley:—Returning to the question of a dry pipe sprinkler system,—if there is not quite enough air in a line the water will come anyway, and if you have freezing weather, away goes the pipe. I can't agree with Mr. Knowles on that sort of a pipe. The only way to be sure about it is to have a man there to shut it off, and keep it shut off.

C. R. Knowles:—This isn't a theory of mine. It is a practice of long standing. We have some 30 or 40 such installations on our line, and they are working satisfactorily. While I am on my feet I want to correct an impression that Mr. Rear evidently has. I am not opposed to his method of fastening the barrel to the bridge in the position of the platform on a level with the ties. I really think it is better than as shown in this report where it is attached to the cap.

A Member:—We have a large storehouse in which we have an automatic sprinkler system, and last spring, by chance, we discovered that our pipes were practically filled with sediment. We used water from a high tower tank as it is at an isolated spot where city water is not available. The sediment and sand practically closed up our piping.

J. S. Robinson:—We have that system in a $500,000 storehouse and we have it inspected once a month.

Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Colo.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428
21	St. Louis, Mo.,	Oct. 17-19, 1911	499
22	Baltimore, Md.,	Oct. 15-17, 1912	524
23	Montreal, Que.,	Oct. 21-23, 1913	570
24	Los Angeles, Cal.,	Oct. 20-22, 1914	586
25	Detroit, Mich.,	Oct. 19-21, 1915	665
26	New Orleans, La.,	Oct. 17-19, 1916	710
27	Chicago, Ill.,	Oct. 16-18, 1917	704
28	Chicago, Ill.,	Oct. 15-17, 1918	716
29	Cleveland, O.,	Oct. 21-23, 1919	776

	1891-2.	1892-3.	1893-4.	1894-5.

	1903-1904.	1904-1905.	1905-1906.	1906-1907.
President ...	A	C. A. Lichty...	J. B. Sheldon...	J. H. Markley.
1st. V.-Pres. .	A	J. B. Sheldon..	J. H. Markley...	R. H. Reid.
2nd. V.-Pres.	C	J. H. Markley..	R. H. Reid......	J. P. Canty.
3rd. V.-Pres.	J	R. H. Reid.....	R. C. Sattley....	H. Rettinghouse.
4th. V.-Pres. .	J	R. C. Sattley...	J. P. Canty......	F. E. Schall.
Secretary	S	S. F. Patterson..	S. F. Patterson..	S. F. Patterson.
Treasurer ...	C	C. P. Austin....	C. P. Austin.....	C. P. Austin.
Executive Members .	R	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	V	A. E. Killam....	A. E. Killam.....	A. E. Killam.
	A	H. Rettinghouse.	J. S. Lemond....	J. S. Lemond.
	R	J. S. Lemond...	C. W. Richey....	C. W. Richey.
	H	W. H. Finley..	H. H. Eggleston.	H. H. Eggleston
	J	C. W. Richey...	F. E. Schall.....	B. J. Sweatt.

	1915-1916	1916-1917	1917-1918	1918-1919
President		C. E. Smith	S. C. Tanner	Lee Jutton
1st. V.-Pres		E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres		S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres		Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.		F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.		C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members		W. F. Strouse	A. Ridgway	J. S. Robinson
		C. R. Knowles	J. S. Robinson	J. P. Wood
		A. Ridgway	J. P. Wood	A. B. McVay
		J. S. Robinson	D. C. Zook	J. H. Johnston
		J. P. Wood	A. B. McVay	E. T. Howson
		D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920
President	F. E. Weise
1st. V.-Pres.	W. F. Strouse
2nd V.-Pres.	C. R. Knowles
3rd V.-Pres.	A. Ridgway
4th V.-Pres.	J. S. Robinson
Sec.-Treas.	C. A. Lichty
Executive Members	J. P. Wood
	A. B. McVay
	J. H. Johnston
	E. T. Howson
	C. W. Wright
	G. A. Manthey

CONSTITUTION *

ARTICLE I.

NAME.

SECTION 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

SECTION 1. The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussions, providing a medium for the exchange of ideas to the end that bridge and building practice may be systematized and improved.

SECTION 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The membership of this association shall be divided into two classes—active and life members.

SECTION 2. To be eligible for active membership, a person must be actively employed in railway service in responsible charge of the design, construction or maintenance of railway bridges, buildings or other structures; a professor of engineering in a college or university of recognized standing; an engineering editor, or a government or private timber expert.

SECTION 3. To be eligible for life membership a person must have been a member of the association for at least five years and in general must have retired from active railway service. The association, however, may waive the latter condition by a majority vote of the members at a regular session for good and sufficient reasons. A life member shall have all the privileges of active membership and shall not be required to pay annual dues.

SECTION 4. Any member guilty of conduct unbecoming a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, may forfeit his membership on a two-thirds vote of the members present at any regular session of the association.

SECTION 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

* Revised October, 1914. Amended October, 1915.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary-treasurer and six executive members, all of whom shall constitute the executive committee.

SECTION 2. The past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECTION 3. Vacancies in any office for the unexpired term shall be filled by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial interests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECTION 2. Two-thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECTION 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association which convenes on the third Tuesday in October, and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

SECTION 2. The president, four vice-presidents and secretary-treasurer shall hold office for one year and the executive members for two years, three being elected each year. All officers will retain their offices until their successors are elected and installed.

SECTION 3. The term of office of the secretary-treasurer may be terminated at any time by a two-thirds vote of the executive committee. His compensation shall be fixed by a majority vote of the executive committee. The secretary-treasurer shall also serve as secretary of the executive committee.

SECTION 4. The secretary-treasurer shall be required to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

ANNUAL DUES.

SECTION 1. Every member upon joining the association shall pay to the secretary-treasurer three dollars membership fee and two dollars per year in advance for annual dues. No member one year in arrears for dues shall be entitled to vote at any election, and any member more than one year in arrears shall be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least sixty days previous to said regular meeting.

BY-LAWS*

TIME OF MEETING.

1. The regular meeting of this association shall convene annually on the third Tuesday in October at 10 a. m.

PLACE OF MEETING.

2. Places of holding the next annual convention may be proposed at any regular session of the association. All the places proposed shall be submitted to a ballot vote of the members present at the annual business session and the place receiving a majority of all votes cast shall be declared the location of the next annual meeting. If no place receives a majority of the votes cast, the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

3. It shall lie within the power of the executive committee to change the location of the meeting place if it becomes apparent that it is for the best interests of the association.

QUORUM.

4. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

DUTIES OF OFFICERS.

5. The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall,

* Revised October, 1914. Amended October, 1915.

with the secretary-treasurer, sign all contracts or other written obligations of the association which have been approved by the executive committee. At the annual meetting the president shall present a report containing a statement of the general condition of the association.

6. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

7. It shall be the duty of the secretary-treasurer to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

NOMINATING COMMITTEE.

8. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, which shall prepare a list of names of nominees for officers to be voted on at the next annual convention, in accordance with Article VI of the constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE.

9. At the first session of each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary-treasurer and certify as to the correctness of his accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

COMMITTEE ON SUBJECTS FOR DISCUSSION.

10. After the annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEES ON INVESTIGATION.

11. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE.

12. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS.

13. 1st—Registration of members.
2nd—Reading minutes of the last meeting.
3rd—Admission of new members.
4th—President's address.
5th—Report of secretary-treasurer.
6th—Payment of annual dues.
7th—Appointment of special committees.
8th—Reports of standing committees.
9th—Unfinished business.
10th—New business.
11th—Election of officers and selection of place for holding next annual meeting.
12th—Installation of officers.
13th—Adjournment.

(Report of nominating committee to be read at first session of second day—Section 9 of By-Laws.)

DECISIONS.

14. The votes of a majority of the members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

15. All discussions shall be governed by Robert's rules of order.

DIRECTORY OF MEMBERS

Aagaard, P., Supt. Bldgs., I. C. R. R., Chicago
Ailes, N. C., Asst. Val. Engr., D. & H. Co., Albany, N. Y.
Airmet, E. S., For. Ptr., O. S. L. R. R., Salt Lake City.
Alexander, S. Y., G. F. B. & B., St. L. B. & M. Ry., Kingsville, Tex.
Alexander, L. B., Asst. Br., Engr., M. C., Detroit, Mich.
Allard, E. E., For. B. & B., Mo. Pac. Ry., St. Louis.
Allen, T. H., Supv. B. & B., C. & O. Ry., Hinton, W. Va.
Althof, L. W., Supt. Hull Const., Chester Ship Yard, Philadelphia, Pa.
Anderson, August, Gen'l For. B. & B., L. S. & I. Ry., Marquette, Mich.
Anderson, L. J., Supv. B. & B., C. & N. W. Ry., Escanaba, Mich.
Andrews, G. W., Asst., M. of W. Dept., B. & O. R. R., Baltimore, Md.
Andrews, T. O., L. E. & W. R. R., Tipton, Ind.
Archbold, H. L., Div. Engr., Sou. Pac. Co., Tucson, Ariz.
Arey, R. J., 541 So. Cummings St., Los Angeles, Calif.
Ashby, E. B., Consulting Engr., L. V. R. R., New York City.
Ashmore, A. B., Supv. B. & B., M. L. & T. Co., Lafayette, La.
Ashton, D. H., Asst. Engr., O. S. L. R. R., Pocatello, Idaho.
Auge, E. J., Chief Carp., C. M. & St. P. Ry., Wells, Minn.
Austin, C. P., 107 Park St., Medford, Mass.

Bach, C. F., Supv. B. & B., C. & N. W. Ry., Belle Plaine, Iowa.
Bailey, F. W., Supt. M. of W., S. A. & A. P. Ry., Yoakum, Tex.
Bailey, S. D., 633 Hubbard Ave., Detroit, Mich.
Bainbridge, C. N., Engr., Design, C. M. & St. P. Ry., Chicago.
Ball, E. E., Div. Engr., A. T. & S. F. Ry., Fresno, Calif.
Ballard, C. F., Carp. For., S. A. L. Ry., Peachland, N. C.
Baluss, F. C., Engr. B. & B., D. M. & N. Ry., Duluth, Minn.
Barber, N. N., C. E., 6042 Vernon Ave., Chicago.
Barger, T. R., For. B. & B., L. & N. W. R. R., Homer, La.
Barnes, O. F., Div. Engr., Erie R. R., Jersey City, N. J.
Barrett, E. K., Supv. B. & B., F. E. C. Ry., St. Augustine, Fla.
Barrett, J. E., Supt. of Track, B. & B., L. & H. R. Ry., Warwick, N. Y.
Barry, E. J.
Barton, M. M., 311 No. 34th St., Philadelphia, Pa.
Bates, Onward, Civil Engineer, McCormick Bldg., Chicago.
Batey, W. A., Supv. B. & B., U. P. R. R., Kansas City, Mo.
Beard, A. H., 705 No. 11th St., Reading, Pa.
Beck, L., Supt. B. & B., Virginian, Victoria, Va.
Beeler, C. L., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
Beeson, R. W., Mast. Carp., C. & S. Ry., Trinidad, Colo.
Bender, Henry, Supv. B. & B., C. & N. W. Ry., Eagle Grove, Iowa.
Bennett, D. E., For. B. & B., Mo. Pac. R. R., DeSoto, Mo.
Bennett, W. J., Asst., Engr., G. N., Seattle, Wash.
Benz, F. A., Div. Engr., B. R. & P. Ry., E. Salamanca, N. Y.
Berry, J. S., Supt. B. & B., S. L. S. W. Ry., Tyler, Tex.
Bibb, J. M., Supv. B. & B., L. & N. R. R., Birmingham, Ala.
Bigelow, F. M., Supv. B. & B., L. A. & S. L. R. R., Salt Lake City.
Bishop, McClellan, Mast. Carp., C. R. I. & P. Ry., El Reno, Okla.
Bishop, R. R., For. B. & B., L. A. & S. L. R. R., Salt Lake City.
Black, G. W., Box 472, Freeport, Ill.

Black, J. D., Supv. B. & B., P. M. R. R., Saginaw, Mich.
Blake, L. M., Supv. B. & B., B. & M. R. R., St. Johnsbury, Vt.
Blowers, S. H., For. Carp., B. & O. R. R., Columbus, O.
Bock, J. G., Gen. Br. Insp., C. St. P. M. & O. Ry., St. Paul, Minn.
Bohland, J. A., Br. Engr., G. N. Ry., St. Paul, Minn.
Bonner, J. K., Asst. Supv. B. & B., N. Y. C. R. R., Rochester, N. Y.
Bourgeois, F. J., Supv. B. & B., N. O. G. N. R. R., Bogalusa, La.
Bouton, W. S., Engr. of Brgs., B. & O. R. R., Baltimore, Md.
Bowers, Stanton, Bradford, O.
Bowers, S. C., Mast. Carp. of Brgs., P. C. C. & St. L. Ry., Steubenville, O.
Bowman, R. M., Certain-teed Prod. Corp., Leader-News Bldg., Cleveland.
Boyd, G. E., Div. Engr., D. L. & W. R. R., Buffalo, N. Y.
Boyer, Grant, Div. For. Bldgs., M. C. R. R., Detroit, Mich.
Bracken, T. F., Gen. For., B. & B., C. St. P. M. & O., Emerson, Neb.
Bratten, T. W., Supv. B. & B., S. P. Co., Oakland Pier, Calif.
Brewer, W. A., Asst. Engr., C. & N. W. Ry., Chicago.
Bricker, H. R., Insp. M. of W., B. & O. R. R., Baltimore, Md.
Briggs, B. A., 1075 LaFayette St., Denver, Colo.
Brink, E. B., Supt. B. & B., L. E. & W., Tipton, Ind.
Brooks, G. E., Mast. Carp., C. R. I. & P. Ry., Rock Island, Ill.
Brown, Alf., B. & B. Insp., P. E. Ry., Los Angeles, Calif.
Brown, C. W., Sou. Pac. Co., Mina, Nevada.
Brown, E. H., Supv. B. & B., N. P. Ry., Minneapolis, Minn.
Brown, Thos., Br. Insp., P. M. R. R., Saginaw, Mich.
Browne, J. B., Gen'l For. B. & B., K. C. C. & S. Ry., Clinton, Mo.
Browne, J. S., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
Bruce, R. J., Gen'l Bldg. Insp., Mo. Pac. Ry., St. Louis, Mo.
Buckley, J. E., Supv. B. & B., B. & M. R. R., Fitchburg, Mass.
Bulger, Hugh, For. B. & B., Sou. Pac. Co., Oakland Pier, Calif.
Buchholz, H. C., Ch. Carp., C. M. & St. P. Ry., St. Maries, Idaho.
Bugg, C., Supv. W. S., G. T., London, Ont.
Burckhalter, F. L., Asst. Gen. Mgr., Sou. Pac. Co., Los Angeles, Calif.
Burgess, W. H., Supv. B. & B., Sou. Pac. Co., Stockton, Calif.
Burke, Daniel, Supv. B. & B., Sou. Pac. Co., Tucson, Ariz.
Burnett, W. L., For. B. & B., Mo. Pac. R. R., Eudora, Ark.
Burns, Fred, G. F. Carp., C. N. O. & T. P., Somerset, Ky.
Burns, W. E., Asst. Engr., S. P. Co., San Francisco (care of G. W. Rear).
Burpee, Moses, Chief Engr., B. & A. R. R., Houlton, Maine.
Burrell, F. L., Supv. B. & B., C. & N. W. Ry., Fremont, Neb.
Busier, T. W., Plumb. For., B. & A. R. R., Pittsfield, Mass.

Cable, C. C., 311 W. Baltimore St., Baltimore, Md.
Caldwell, C. H., For. B. & B., Sou. Pac. Co., E. Bakersfield, Calif.
Caldwell, J. M., Insp. B. & B., C. I. & L. Ry., Lafayette, Ind.
Caldwell, J. T., For. B. & B., Sou. Pac. Co., Bakersfield, Calif.
Camp, W. M., Editor, Railway Review, Chicago, Ill.
Candee, Eldridge E., Sup. B. & B., NY NH & H RR, New London, Conn.
Candee, Elliot E., Dist. Br. For., N. Y. N. H. & H. RR, Waterbury, Conn.
Canty, J. P., Div. Engr., B. & M. R. R., No. Adams, Mass.
Cardwell, W. M., Supv. B. & B., W. T. Co., Washington, D. C.
Carmichael, Wm., 2736 Walker Ave., Kansas City, Kans.
Carmody, M. M., Supv. B. & B., Sou., Big Stone Gap, Va.
Carpenter, J. T., 619 So. Gibson St., Princeton, Ind.
Cary, E. L., Richmond, Mo.
Case, F. M., For. W. S., C. & N. W. Ry., Belle Plaine, Iowa.
Casey, W. W., For. B. & B., K. C. S. Ry., Texarkana, Tex.
Catchot, A. J., Supv. B. & B., L. & N. R. R., Ocean Springs, Miss.
Cavanaugh, Wm., Asst. Supv. B. & B., N. Y. C. R. R., Oswego, N. Y.
Cayley, W., Supv., G. T. Ry., Stratford, Ont.
Chapin, F. H., Asst. Br. Engr., Alaskan Eng. Com., Anchorage, Alaska.
Clapper, L., Engr., B. & B., D. & I. R., Two Harbors, Minn.

Clark, H. W., Supv. B. & B., Mo. Pac. R. R., Atchison, Kans.
Clark, J. H., M. of W. Clerk, Sou. Pac. Co., Tucson, Ariz.
Clark, W. A., Chief Engr., D. & I. R. R. R., Duluth, Minn.
Clarke, J. B., Mast. Carp., B. & O. R. R., Chillicothe, O.
Clopton, A. S., Supv. B. & B., M. K. & T. Ry., Oklahoma City, Okla.
Clothier, E. E., Chief Carp., C. M. & St. P. Ry., Mobridge, So. Dak.
Coffin, S. P., 1299 Commonwealth Ave., Allston, Mass.
Colclough, E., Gen. For. B. & B., A. T. & S. F. Ry., Fresno, Calif.
Cole, J. E., Am. Opt. Co., 32 Coombs St., Southbridge, Mass.
Collings, Edwd., Chief Carp., C. M. & St. P. Ry., Perry, Iowa.
Conn, F. J., Supv. B. & B., C. N. O. & T. P. Ry., Lexington, Ky.
Cooper, H. A., Roadmaster, T. I. Ry., Gananoque, Ont.
Copland, A. C., Office Engr., C. & O. Ry., Richmond, Va.
Copp, J. P., Roberts & Schaeffer Co., McCormick Bldg., Chicago.
Corbin, W. S., For. B. & B., Sou. Pac. Co., San Pedro, Calif.
Corey, S. T., Asst. Br. Engr., C. R. I. & P. Ry., Chicago.
Corrigan, M. M., Gen. Insp. Tunnels, B. & O. R. R., Cumberland, Md.
Cota, G. M., Ch. Acct., Stores Dept., C. Vt. Ry., St. Albans, Vt.
Counts, D. E., Supv. B. & B., W. & A. R. R., Chattanooga, Tenn.
Cowsert, L. A., Supv. W. S., C. N. O. & T. P. Ry., Danville, Ky.
Crawford, I. C., Supv. B. & B., D. & R. G. R. R., Salt Lake City.
Crawford, J. A., B. & B. Master, C. N. Ry., Saskatoon, Sask.
Creeks, J. L., For. B. & B., Sou. Pac. Co., Dunsmuir, Calif.
Crites, G. S., Div. Engr., B. & O. R. R., Baltimore, Md.
Cronin, Jno., Supv. B. & B., C. & N. W. Ry., Winona, Minn.
Crosby, P., Supv. B. & B., N. Y. N. H. & H. R. R., Danbury, Conn.
Cullen, F. P., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Cullen, J. F., For. B. & B., O. S. L. R. R, Pocatello, Idaho.
Cummin, J. H., Insp. Heatg., L. I. R. R., Jamaica, N. Y.
Cunningham, A. O., Chief Engr., Wabash R. R., St. Louis, Mo.
Curry, Jno., For. B. & B., Mo. Pac. R. R., McGehee, Ark.
Curtin, William, Contractor, Govan, Saskatchewan.

Dalstrom, O. F., Br. Engr., C. & N. W. Ry., Chicago.
Danes, E. C., Supv. B. & B., Wabash R. R., Montpelier, Ohio.
Davidson, J. K., Mast. Carp., Pa. Lines W., Jamestown, Pa.
Decker, H. H., Contractor, 2915 Ingersoll Ave., Des Moines, Iowa.
Demars, E. A., G. F. Plumb. & W. S., O. S. L. R. R., Salt Lake City
Derr, W. L., Supt., C. G. W. R. R., Clarion, Iowa.
de Ximeno, A., C. C. S. Corp., Obispo 59, altos, Havana, Cuba.
Dickerson, O. H., Prin. Asst. Engr., D. & I. R. R. R., Duluth, Minn.
Dickson, Geo., For. Brdgs., Sou. Pac. Co., Oakland, Calif.
Dickson, G. H., Asst. Engr., B. &B., T. & N. O. Ry., North Bay, Ont.
Dillabough, J. V., Asst. Dist. Engr., C. N. Ry., Edmonton, Alta.
Dittmar, F. C., Br. For., Sou. Pac. Co., Los Angeles, Calif.
Dodd, A. M., Supv. B. & B., C. of Ga. R. R., Macon, Ga.
Donaldson, C. E., Supv. B. & B., C. Vt. R. R., St. Albans, Vt.
Douglas, L. H., Mast. Carp., B. & O R. R., Cleveland, O.
Drake, R. M., M. of W. Asst., Sou. Pac. Co., San Francisco, Calif.
Draper, F. O., Supt. of Brdgs., I. C. R. R., Chicago.
Draper, I. A., Steel Erec. For. O. S. L. R. R., Pocatello, Idaho.
Drum, H. R., Chief Carp., C. M. & St. P. Ry., Mitchell, S. D.
Drury, Edwd., Gen. For. B. & B., A. T. & S. F. Ry., Newton, Kans.
Duckett, W. E.
Dufort, S. E., Supv. B. & B., B. & M. R. R., Concord, N. H.
Dupree, Jas., Supt. B. & B., C. T. H. & S. E. Ry., Chicago.
Durfee, T. H., Supv. B. & B., C. & N. W. Ry., Huron, S. D.

Easton, G. A., Gen. Scale Insp., Sou. Pac. Co., West Oakland, Calif.
Edwards, W. R., Sr. Struct. Engr., I. C. C., Washington, D. C.
Eggers, C. H., Mast Carp., C. R. I. & P. Ry., Little Rock, Ark.

Eggleston, H. H., Supv. B. & B., C. G. W. R. R., Des Moines, Iowa.
Eggleston, W. O., Insp. of Brdgs., Erie R. R., Huntington, Ind.
Elder, W. E., 720 So. 4th St., Burlington, Iowa.
Elliott, R. O., Supv. B. & B., L. & N. R. R., Nashville, Tenn.
Elwell, H. A., Supv. B. & B., C. G. W. Ry., St. Paul, Minn.
Enright, J. L., Gen. Supv. B. & B., St. L. S. W., Tyler, Tex.
Eskridge, F. A., Archt., C. & E. I. R. R., Chicago.
Esping, Chas., Mast. Carp., B. & O. C. T. R. R., Chicago.
Estes, C. F., For. Brdgs., Pac. Elec. Ry., Los Angeles, Calif.
Estes, F. K., Asst. Supv. B. & B., U. P., Denver, Colo.
Ettinger, C., Gen. Ptr. For., I. C. R. R., Chicago.
Eubanks, J. E., Br. For., S. A. L. Ry., Yulee, Fla.
Everett, D. D., For. Plumb., Erie, Jersey City, N. J.

Fair, E. W., Supv. B. & B., B. R. & P. Ry., Du Bois, Pa.
Fake, C. H., R. F. D. No. 3, Salem, Oregon.
Farlow, R. F., Mast. Carp., B. & O. R. R., Tompkinsville, S. I., N. Y.
Fellows, C. W., For. W. S., C. & S. Ry., Denver, Colo.
Fenwick, G. H., Gen. Br. For., M. C. R. R., St. Thomas, Ont.
Ferdina, A. H., For. B. & B., Mo. Pac. R. R., St. Louis, Mo.
Ferris, B. F., For. B. & B., Sou. Pac. Co., Los Angeles, Calif.
Findley, A., 929 Wash. Ave., Portland, Me.
Fink, Albert, Gen. For. B. & B., D. L. & W. R. R., Buffalo, N. Y.
Finley, W. H., President, C. & N. W. Ry., Chicago.
Firehammer, L. M., Supv., B. & B., Ill. Trac., Gillespie, Ill.
Fisher, J. F., Br. Insp., Sou. Pac. Co., Sacramento, Calif.
Fisher, Morris, Supv. B. & B., Sou. Pac. Co., Ogden, Utah.
Fisk, C. H., Ch. Engr. Const., St. Louis, 5142 Westminster Pl., St. Louis.
Fitzgerald, J. M., Ch. Engr's. Office, C. of Ga. R. R., Savannah, Ga.
Fletcher, J. W., Roadway Supt., Car. & N. W. Ry., Chester, S. C.
Fletcher, W. H., Room 21, Vauxhall Apt., Nashville, Tenn.
Flynn, M. J., Supv. B. & B., C. & N. W. Ry., Chicago.
Fraser, Alex., Supv. B. & B., Sou. Pac. Co., Bakersfield, Calif.
Fraser, James, Ch. Engr., N. S. W. Govt. Rys., Sydney, N. S. W.
Fraser, Neil, Supv. B. & B., Sou. Pac. Co., Dunsmuir, Calif.
Frazer, H. H., Div. For., Sou. Pac. Co., Dunsmuir, Calif.
Frazier, W. C., Supv. B. & B., L. A. & S. L. Ry., Los Angeles, Calif.
Froese, Julius, Gen. For. B. & B., A. T. & S. F. Ry., LaJunta, Colo.
Fullerton, J. H., Supv. B. & B., B. & M. R. R., Woodsville, N. H.

Gable, Franklin, For. Carp., P. & R. Ry., Catawissa, Pa.
Gaby, F. A., Ch. Engr., Hydro-Elec. P. C. of Ont., Toronto, Ont.
Gagnon, Ed., 408 Bryant Ave. North, Minneapolis, Minn.
Gallagher, J. P., Insp. Fire Protec., N. Y. C. R. R., New York City.
Gantz, W. R., Mast. Carp., P. R. R., Philadelphia, Pa.
Gardner, E. F., Mast. Carp., Erie R. R., Buffalo, N. Y.
Garner, R. D., Engr. Const., S. N. E. Ry., Providence, R. I.
Gault, A. K., Div. Engr., C. & N. W. Ry., Omaha, Neb.
Gaut, J. B., Supt. B. & B., G. T. R., Detroit, Mich.
Gauthier, A. I., Supv. B. & B., B. & M. R. R., Concord, N. H.
Gehr, B. F., Mast. Carp., P. C. C. & St. L. Ry., Richmond, Ind
Gentis, Ira, For. B. & B., Sou. Pac. Co., Oakland, Calif.
George, W. J., Bay Road, Claremont, W. Australia.
Gerst, H. A., Asst. Br. Engr., G. N. Ry., St. Paul, Minn.
Getman, Frank, Mast. Carp., Erie, Youngstown, O.
Gibson, J. M., Supv. B. & B., G. T. R. in New Eng., Portland, Me.
Gilman, A. F., 530 Ashland Ave., St. Paul, Minn.
Giusto, Peter, For. B. & B., Sou. Pac. Co., San Francisco.
Gnadt, C. C., Br. For., Mo. Pac. R. R., Desoto, Mo.
Goldmark, Henry, Cons. Engr., 103 Park Ave., New York City.
Goldsmith, E. L., Supt. Const., L. I. R. R., Jamaica, N. Y.

Golson, W. P., Roadmaster, C. of Ga. Ry., Macon, Ga.
Gongoll, O. C., Asst. Supt. B. & B., Soo Line, Minneapolis, Minn.
Gooch, C. W., 1325 W. 9th St., Des Moines, Iowa.
Gradt, Chas., Ch. Carp., C. M. & St. P. Ry., Savanna, Ill.
Graham, F. N., Asst. Engr., D. M. & N. Ry., Duluth, Minn.
Gratto, James, Supv. B. & B., S. P. Co., Los Angeles, Calif.
Graves, Lon, For. B. & B., Mo. Pac. R. R., Dermott, Ark.
Green, C. F., Supv. B. & B., Sou. Pac. Co., Sacramento, Calif.
Green, E. H. R., Pres., Texas Midland R. R., Terrell, Tex.
Green, Z. A., Pilot, Fed. Val., G. C. & S. F. Ry., Galveston, Tex.
Greiner, J. E., Civil Engr., 605 Continental Bldg., Baltimore, Md.
Griffith, F. M., Supv. B. & B., C. & O. Ry., Covington, Ky.
Griffith, W. J., Mas. For., B. & A. R. R., Pittsfield, Mass.
Groeninger, H. J., Mast. Carp., P. R. R., Oil City, Pa.
Grover, J. H., Gen. For. W. S., A. T. & S. F. Ry., Needles, Calif.
Guild, Edward, Supv. B. & B., P. M. R. R., Grand Ledge, Mich.
Guire, W. A., For. B. & B., Mo. Pac. R. R., Lake Providence, La.
Guppy, B. W., Engr., Structures, B. & M. R. R., Boston, Mass.

Haag, Orin, Carp. For., B. & O. R. R., Garrett, Ind.
Hadwen, L. D., Engr. Masy. Const., C. M. & St. P. Ry., Chicago.
Haley, W. S., Asst. Div. Engr., N. Y. C. R. R., Toledo, O.
Hall, N. L., Roadmaster, Sou. Ry., Winston-Salem, N. C.
Hall, Thomas, Asst. Supt. Bldgs., M. C. R. R., Jackson, Mich.
Hamer, John, Supv. Bldgs., N. Y. C. R. R., Albany, N. Y.
Hampton, H. A., Asst. Div. Engr., Sou. Pac. Co., Portland, Oregon.
Hancock, John, Asst. Engr., N. Y. C. R. R., Crown Bldg., Cleveland, O.
Hand, Geo. W., Valuation Engr., C. & N. W. Ry., Chicago.
Hanks, G. E., 814 No. Wash. Ave., Saginaw, Mich.
Hansen, Robt., Carp. For. Sou. Pac. Co., West Oakland, Calif.
Hansen, Rupert, 517 Redondo Ave., Salt Lake City, Utah.
Hanson, J. A., Supv. B. & B., C. C. C. & St. L., Mt. Carmel, Ill.
Hargrove, J. C., For. B. & B., Mo. Pac. R. R., McGehee, Ark.
Harlow, A. W., Mast. Carp., Erie R. R., Huntington, Ind.
Harman, H. H., Engr. of Brdgs., B. & L. E. R. R., Greenville, Pa.
Harman, Wm. C., Br. Insp., Sou. Pac. Co., Bakersfield, Calif.
Harris, W. B., Roadmaster, M. & O. R. R., Murphysboro, Ill.
Harrison, Chas., Gen. For. B. & B., M. V. Ry., Excelsior, Ark.
Harshbarger, C. A., Asst. Br. For., O. S. L. Ry., Ontario, Ore.
Hartley, James, Supv. B. & B., N. P. Ry., Staples, Minn.
Hartwell, J. R., Supv. B. & B., P. R. C. & N. W. Ry., Pierre, S. D.
Harvey, E. H., Foundation Shipbuilding Co., Portland, Ore.
Harvey, T. J., Bridge Insp., B. &. A. R. R., Pittsfield, Mass.
Hausgen, W., Supv. B. & B., Mo. Pac. R. R., Sedalia, Mo.
Hawk, A. T., Engr. Bldgs., C. R. I. & P. Ry., Chicago.
Hawken, F. G., Insp. B. & B., D. S. S. & A., Marquette, Mich.
Hawkins, E. P., Gen'l R. M., Mo. Pac. R. R., McGehee, Ark.
Hayes, J. L., Div. Engr., C. R. I. & P. Ry., Rock Island, Ill.
Heiszenbuttel, H., Supv. B. & B., C. & N. W. Ry., Norfolk, Neb.
Helick, R. H., Mast. Carp., P. R. R., Pittsburgh, Pa.
Henderson, J., For. B. & B., G. T. Ry., St. Thomas, Ont.
Henderson, R. C., Mast. Carp., B. & O. R. R., Dayton, O.
Henry, R. F., Supv. B. & B., C. C. C. & St. L., Galion, O.
Herrig, C., For. W. S., C. & N. W. Ry., Wall Lake, Iowa.
Heuss, C. W., Supv. B. & B., C. C. C. & St. L., Indianapolis, Ind.
Higgins, H. K., Const. Engr., 209 McBride St., Jackson, Mich.
Hill, H. R., Asst. Supv. B. & B., L. & N. R. R., Birmingham, Ala.
Hillman, F. W., Div. Engr., C. & N. W. Ry., Chicago.
Hinchee, J. M., For. B. & B., Sou. Pac. Co., Los Angeles, Calif.
Hitesman, U. S., Gen. For., N. Y. C. R. R., New York City.
Hodges, F. J., C. C., M. C. R. R., Jackson, Mich.

Hodges, H. P., 412 Pallister Ave., Detroit, Mich.
Hofecker, Peter, Supv. B. & B., L. V. R. R., Auburn, N. Y.
Hoffman, Geo. M., For. Ptr., P. & R. Ry., Shamokin, Pa.
Holcomb, J. W., Supv. B. & B., L. V. R. R., Buffalo, N. Y.
Holdridge, H. D., Supv. B. & B., Y. & M. V. R. R., Vicksburg, Miss.
Hopke, W. T., Mast. Carp., B. & O. R. R., Grafton, W. Va.
Horning, H. A., Supt. of Bldgs., M. C. R. R., Jackson, Mich.
Horth, A. J., Mast. Carp., Erie R. R., Meadville, Pa.
Hotson, Wm. B., Supt. B. & B., E. J. & E. Ry., Joliet, Ill.
Howay, B. J., For. B. & B., P. M., Saginaw, Mich.
Howson, E. T., Ed. Mtce. Engr., 608 So. Dearborn St., Chicago.
Hubbard, A. B., 32 Banks St., West Somerville, Mass.
Hudson, B. M., Supt. T. & B. V. Ry., Teague, Tex.
Hull, H. L., C. C., Eng. Dept., C. T. H. & S. E., Chicago.
Hull, K. S., Gen'l Supt., G. C. & S. F. Ry., Galveston, Tex.
Humbert, A. T. Mast. Carp., B. & O. R. R., New Castle Jct., Pa.
Hume, E. S., Deputy Com'r., W. A. Govt. Rys., Perth, W. Australia.
Hunciker, John, For. Br. Erec., C. & N. W. Ry., Chicago.
Huntoon, J. S., Asst. Br. Engr., M. C. R. R., Detroit, Mich.
Hutchens, J. A., Gen. For. W. S., Sou. Pac. Co., Ogden, Utah.

Ingalls, F., Supv. B. & B., N. P. Ry., Jamestown, N. D.
Ingram, Floyd, Supv. B. & B., L. & N. R. R., Paris, Tenn.
Innes, J., Gen. For. G. T. Ry., Hamilton, Ont.
Irving, T. J., Div. Engr., C. & N. W. Ry., So. Pekin, Ill.
Irwin, J. W., Supv. B. & B., C. & N. W. Ry., Chadron, Neb.
Isaacs, Jno. D., Cons. Engr., Sou. Pac. Co., New York City.

Jack, H. M., 519 W. Kolstad St., Palestine, Tex.
Jackson, C. T., Dist. Engr., C. M. & St. P. Ry., Chicago.
Jackson, E. A., For. B. & B., Mo. Pac. R. R., McGehee, Ark.
Jackson, W. J., Div. Engr., C. & N. W. Ry., Winona, Minn.
James, A. J., Gen. For. B. & B., A. T. & S. F. Ry., Topeka, Kans.
Jamison, G. H., Ch. Carp., C. M. & St. P. Ry., Harlowtown, Mont.
James, Harry, Gen'l For. B. & B., C. & S. Ry., Denver, Colo.
James, R. E., Supv. B. & B., L. V. R. R., Sayre, Pa.
James, Wm., Carp. For., I. C. R. R., New Orleans, La.
Jennings, Geo. H., Mgr., Powers-Thompson Const. Co., Joliet, Ill.
Jensen, C. A., For. B. & B., Sou. Pac. Co., Los Angeles, Calif.
Jewell, J. O., Supt. B. & B., C. T. H. & S. E. Ry., Terre Haute, Ind.
Johnson, B. L., Gen. Mast. Carp., G. N., Spokane, Wash.
Johnson, C. H., For. B. & B., P. M. R. R., Reese, Mich.
Johnson, E. H., For. Plumb., Erie, Elmira, N. Y.
Johnson, Maro, Asst. Engr., I. C. R. R., Chicago.
Johnson, Nels, Supv. B. & B., C. G. W. R. R., St. Charles, Ill.
Johnson, Phelps, Pres. St. Lawrence Bridge Co., Montreal, Que.
Johnston, C. E., Gen'l Mgr., K. C. Sou. Ry., Kansas City, Mo.
Johnston, J. H., Supt. B. & B., G. T. Ry., Montreal, Que.
Johnston, T. P., R. E., Sou. Pine Assn., New Orleans, La.
Jonah, F. G., Chief Engr., St. L. S. F. R. R., St. Louis, Mo.
Jonas, H. F., Engr. Struct., S. P. Lines, Tex. & La., Houston, Tex.
Jones, L. E., Asst. Engr., N. O. & N. E. R. R., New Orleans, La.
Jones Pusey, Act. Engr. Strs., B. & M. R. R., Boston, Mass.
Joslin, Judson, Gen'l For. B. & B., L. V. R. R., Auburn, N. Y.
Jutton, Lee, Trainmaster, C. & N. W. Ry., Madison, Wis.

Keefe, D. A., Cons. Engr., Athens, Pa.
Keith, H. C., Cons. Engr., 13 Park Row, New York City.
Keir, W. E., Gen. For. W. S., A. T. & S. F. Ry., San Bernardino, Calif.
Kelly, C. W., Peoples Gas Building, Chicago.
Kelly, J. A., Asst. Supv. B. & B., O. S. L. R. R., Pocatello, Idaho.

Kemmerer, W. G., Asst. Mast. Carp., P. R. R., Erie, Pa.
Kemp, A. E., For. B. & B., L. V. R. R., Hazelton, Pa.
Kendall, M., Mast. Carp., C. & W. I. R. R., Chicago. (83rd & Vinc.)
Kibbey, G. S., Asst. Engr., M. & St. L. R. R., Minneapolis, Minn.
Killam, A. E., 84 Highfield St., Moncton, N. B.
King, A. H., Supv. B. & B., O. S. L. R. R., Pocatello, Idaho.
King, C. F., Asst. Engr., C. & N. W. Ry., Omaha, Neb.
King, F. E., Dist. Carp., C. M. & St. P. Ry., Chicago.
King, T. H., Supv. B. & B., L. & N. R. R., Knoxville, Tenn.
Kinzie, H. H., Supv. B. & B., N. Y. N. H. & H. R. R., Taunton, Mass.
Klumpp, G. J., Supv. Bridges, N. Y. C. R. R., Rochester, N. Y.
Knapp, F. A., Mast. Carp., Erie R. R., Jersey City, N. J.
Knapp, G. A., Office Engr., G. C. & S. F. Ry., Galveston, Tex.
Knowles, C. R., Supt. Water Service, I. C. R. R., Chicago.
Krausch, W. T., Engr. Bldgs., C. B. & Q. R. R., Chicago.
Kulp, B. R., Trainmaster, C. & N. W. Ry., Chicago.
Kurokochi, S., Engr., Imperial Govt. Rys., Tokyo, Japan.

Lacy, J. D., Insp., S. A. & A. P., Ry., 1410 Calhoun St., Houston, Tex.
Lacy, W. J., For. B. & B., Mo. Pac. R. R., Poplar Bluff, Mo.
La Fountain, N. H., Gen. Supv. Bldgs., C. M. & St. P. Ry., Chicago.
Land, G. W., Supv. B. & B., Mo. Pac. R. R., McGehee, Ark.
Large, H. M., Mast. Carp., G. R. & I. Ry., Fort Wayne, Ind.
Larsen, A., Div. Engr., Miami Con. Dist., Dayton, O.
Larson, John, Room 740 Transportation Bldg., Chicago.
Lattin, W. V., Supv. B. & B., N. Y. N. H. & H. R. R., Hartford, Conn.
Lawrence, E. K., Gen. Scale Insp., B. & O. R. R., Baltimore, Md.
Lawrence, P. P., Asst. Supv. B. & B., L. E. & W. R. R., Tipton, Ind.
Layfield, E. N., C. E., Care Hope Eng. & Sup. Co., Mt. Vernon, O.
Leach, W. A., 99 Essex St., Holyoke, Mass.
Leake, T. S., Contractor, 6433 Kenwood Ave., Chicago.
Leavitt, F. J., Div. For. B. & B., B. & M. R. R., Sanbornville, N. H.
Lee, Frank, Engr. M. of W., C. P. R., Montreal, Que.
Lemond, J. S., Asst. to Ch. Engr. M. of W. & S., Sou. Ry., Charlotte, N. C.
Lentz, C. W., Gen. Br. Insp., I. C. R. R., Memphis, Tenn.
Leonard, H. R., Engr., B. & B., P. R. R., Philadelphia, Pa.
Leslie, Andrew, Div. For., M. C. R. R., St. Thomas, Ont.
Lewis, E. R., Railway Age, Transportation Bldg., Chicago.
Lichty, C. A., Gen. Insp., C. & N. W. Ry., Chicago.
Little, C. A., Div. For. B. & B., B. & A. R. R., Concord, N. H.
Littlefield, E. C., Ch. Clk., N. Y. N. H. & H. R. R., New Haven, Conn.
Livingston, J. B., Supv. B. & B., St. L. S. W., Illmo, Mo.
Lloyd, F. F., C. E., Petaluma, Calif
Lodge, Harry, For. B. & B., Sou. Pac. Co., (care of G. W. Rear).
Loeffler, M., Supv. Brdgs., L. I. R. R., Jamaica, N. Y.
Loftin, E. L., Roadmaster, Q. & C. Ry., Vicksburg, Miss.
Long, M. A., C. E., 1523 Munsey Bldg., Baltimore, Md.
Lorch, J. A., Asst. Engr., C. & N. W. Ry., Chicago.
Loughery, E., Gen. For. B. & B., T. & P. Ry., Dallas, Tex.
Loughnane, George, Div. Engr., C. & N. W. Ry., Escanaba, Mich.
Loweth, C. F., Ch. Engr., C. M. & St. P. Ry., Chicago.
Loweth, F. C., Asst. Track Elev. Engr., C. M. & St. P. Ry., Chicago.
Lutken, P. K., Gen. For. B. & B., N. O. M. & C. R. R., Laurel, Miss.
Lydston, W. A., 105 Norfolk Ave. Swampscott, Mass.
Lyman, C. R., For Brdgs., C. Vt., Ry., Waterbury, Vt.

Mace, B. S., Supt. of Insurance, B. & O. R. R., Baltimore, Md.
Mackenzie, W. B., Civil Engineer, Moncton, N. B.
Macy, E. C., Mgr. Trans. & Stores, Hog Island, Pa.
Mahan, Wm., Supt. B. & B., W. & L. E. R. R., Canton, O.
Main, W. T., Div. Engr., C. & N. W. Ry., Chadron, Neb.
Manley, B. F., Gen. For. B. & B., Pac. Elec. Ry., Los Angeles, Calif.

Mann, J. M., Gen. For. B. & B., F. W. & D. C. Ry., Childress, Tex.
Mansfield, A. G., Office Engr., C. M. & St. P. Ry., Seattle, Wash.
Manson, E. F., Office Engr., C. R. I. & P. Ry., Des Moines, Iowa.
Manthey, G. A., Supt. B. & B., D. S. S. & A. R. R., Marquette, Mich.
Marcy, C. A., Supv. B. & B., C. & N. W. Ry., Chicago.
Markley, A. S., Mast. Carp., C. & E. I. R. R., Danville, Ill.
Markley, J. H., Mast. B. & B., T. P. & W. Ry., Peoria, Ill.
Marsh, M. M., Supt. W. & B., Northern Ry., Squirres, Costa Rica, C. A.
Maruyama, Y., Engr. in Chief, Kirin-Changchun Ry., Manchuria.
Massenburg, W. G., Dist. Engr., G. C. & S. F. Ry., Galveston, Tex.
Mattos, F. D., Supt. Pres. Wks., S. P. Co., W. Oakland, Calif.
Matthews, W. H., Mast. Carp., Erie R. R., Salamanca, N. Y.
May, A. D., Asst. Engr., Mo. Pac. Ry., Little Rock, Ark.
May, Frank, For. B. & B., Mo. Pac. R. R., Charleston, Mo.
Mayer, M. J., Ch. Draftsman, Sou. Pac. Co., San Francisco, Calif.
McCabe, E. M., Supv., B. & B., B. & A. R. R., Pittsfield, Mass.
McCandless, C. W., For. B. & B., Sou. Pac. Co., Ventura, Calif.
McCann, E., Gen. For. B. & B., A. T. & S. F. Ry., Wellington, Kans.
McCaulley, S. W., Cons. Engr., 1428 E. 68th St., Chicago.
McClanahan, S. L., Div. Engr., C. R. I. & P. Ry., Herington, Kans.
McCloy, A. L., For. B. & B., P. M. R. R., Reese, Mich.
McClure, J. C. E., Asst., Engr., Sou. Pac. Co., Los Angeles, Calif.
McCormick, R. S., Ch. Engr., A. C. & H. B. R., Sault Ste. Marie, Ont.
McCue, G. C. Gen. Supv. B. & B., G. T. Ry., Ottawa, Ont.
McCully, C. S., Gen. For. B. & B., N. P. Ry., Jamestown, N. D.
McDearmid, W. A., Mast. Carp., S. A. L. Ry., Charleston, S. C.
McDonald, Hunter, Ch. Engr., N. C. & St. L. Ry., Nashville, Tenn.
McFadden, T. E., Chief Carp., C. M. & St. P. Ry., Cedar Falls, Wash.
McFarland, C. W., For. Carp., P. & R., Reading, Pa.
McGee, Danl., For. B. & B., Sou. Pac. Co., Sacramento, Calif.
McGonagle, W. A., Pres., D. M. & N. Ry., Duluth, Minn.
McGuire, Edwd., Ch. Carp., C. M. & St. P. Ry., Marion, Iowa.
McHugh, W. H., Mast. Carp., P. R. R., Olean, N. Y.
McIlhenny, O. R., Office Engr., Chickasaw Shipbuilding Co., Mobile, Ala.
McIntosh, Wm., Castle Stuart, Dalcross, Inverness-shire, Scotland.
McIver, B. T., R. F. D. No. 2, Box 367 B, Long Beach, Calif.
McKay, A. G., Supv. B. & B., N. Y. N. H. & H. R. R., New Haven, Conn.
McKee, D. L., Mast. Carp., P. & L. E. R. R., McKee's Rocks, Pa.
McKee, H. C., Supt. Brgs., C. of Ga. R. R., Savannah, Ga.
McKeel, W. S., Mast. Carp., G. R. & I. Ry., Grand Rapids, Mich.
McKibben, Robert, Mast. Carp., P. R. R., Altoona, Pa.
McLean, Neil, Br. Insp., Erie R. R., Huntington, Ind.
McLeod, Angus, M., For. B. &B., Sou. Pac. Co., Oakland, Calif.
McMahon, Thos. D., Architect, G. N. Ry., St. Paul, Minn.
McNab, A., Supv. B. & B., P. M. R. R., Holland, Mich.
McNaughton, H. C., Div. For. B. & B., B. & M. R. R., Concord, N. H.
McRae, D. A., Carp. For., C. P. R., Lethbridge, Alberta.
McRostie, Roy, Asst. For. Const., O. S. L. R. R., Pocatello, Idaho.
McVay, A. B., Supv. B. & B., L. & N. R. R., Evansville, Ind.
Meier, G. A., For. B. & B., O. S. L., Brigham, Utah.
Mellgren, J., For. W. S., C. & N. W. Ry., Eagle Grove, Iowa.
Meyers, W. F., Supv. B. & B., C. & N. W. Ry., Boone, Iowa.
Miller, A. F., Mast. Carp., Penn. Lines W. of Pitts., Chicago.
Miller, C. E., Scale Insp., C. & N. W. Ry., Chicago.
Miller, J. W., Archt., C. & N. W. Ry., Chicago.
Miller, M. D., Spl. Engr., 740 Transportation Bldg., Chicago.
Miller, R. E., Br. Engr., St. L. S. F., St. Louis, Mo.
Mills, E. A., Gen. Mast. Carp., G. N., Crookston, Minn.
Mills, R. P., Supv. Bldgs., N. Y. C. R. R., New York City.
Mitchell, F. H., Mast. Carp., P. R. R., Ft. Wayne, Ind.
Mitchell, G. A., Supt. B. & B., G. T. Ry., Toronto, Ont.

Mitchell, L. A., Eng. M. & W., U. T. Co. of Ind., Anderson, Ind.
Moen, J. D., Major, U. S. Army.
Montzheimer, A., Ch. Engr., E. J. & E. Ry., Joliet, Ill.
Moore, C. J., Mast. Carp., St. L. S. W. Ry., Pine Bluff, Ark.
Moore, E. G., For. Carp., B. & O. R. R., Flatwoods, W. Va.
Moore, W. H., Engr. of Strs., N. Y. N. H. & H. R. R., New Haven, Conn.
Moreau, C. L., Gen. For., B. & A. R. R., Springfield, Mass.
Morgan, Homer, For. B. & B., P. M. R. R., Greenville, Mich.
Morin, Theo., Br. For., B. & A. R. R., Pittsfield, Mass.
Morrison, E. C., Div. Engr., Sou. Pac. Co., San Francisco.
Mountain, G. A., Ch. Engr., Ry. Com. of Canada, Ottawa, Ont.
Mulcahy, W. H., Supv. B. & B., C. & N. W. Ry., Adams, Wis.
Murphy, J. J., For. W. S., Sou. Pac. Co., Oakland, Calif.
Murphy, R. E., For. B. & B., Sou. Pac. Co., Bakersfield, Calif.
Murray, J. R., Supv. B. & B., A. G. S. R. R., Tuscaloosa, Ala.
Murray, Edwd., Asst. Engr. B. & B., C. M. & St. P. Ry., Miles City, Mont.
Musgrave, C. T., For. B. & B., O. S. L. R. R., Idaho Falls, Idaho.
Musser, D. G., Mast. Carp., Penn. Lines W. of Pitts., Wellsville, O.
Musson, C. A. W., Asst. Engr., C. M. & St. P. Ry., Seattle, Wash.

Nelson, M. E., Engr. Brgs., A. C. L. R. R., Wilmington, N. C.
Nelson, O. T., Engr. M. of W., A. & W. P. R. R., Atlanta, Ga.
Nelson, P. N., Supv. B. & B., Sou. Pac. Co., San Francisco, Calif.
Newton, E. O., Div. For. Bldgs., N. Y. N. H. & H. R. R., Danbury, Conn.
Newton, R., Chester Shipbuilding Co., 101 W. 7th St., Chester, Pa.
Nies, A. B., Archt., M. C. R. R., Jackson, Mich.
Noland, W. B., Supv. B. & B., O. A. & E. Ry., Sacramento, Calif.
Nuelle, J. H., Gen. Supt., N. Y. O. & W. R. R., Middletown, N. Y.
Nuss, G. K., Gen. For. B. & B., D. M. & N. Ry., Proctor, Minn.

Oaksmith, A., Supt. B. & B., Md. Elec. Rys., Annapolis, Md.
O'Brien, W. J., Dist. Carp., C. M. & St. P. Ry., Milwaukee, Wis.
O'Connell, Jno., Ptr. For., B. & A. R. R., Pittsfield, Mass.
O'Connor, W. F., Supv. Brgs., L. I. R. R., Flushing, N. Y.
Oetzman, Emil, For. W. S., A. T. & S. F. Ry., Fresno, Calif.
O'Hara, T., B. & B. Mast., C. P. R., London, Ont.
Oldham, W. J., B. & B. Mast., T. & N. O. Ry., North Bay, Ont.
O'Neill, P. J., Mast. Carp., N. Y. C. R. R., Adrian, Mich.
Oppelt, H. H., Supv. B. & B., N. Y. C. & St. L., Conneaut, O.
Osborn, F. C., Cons., Engr., 2848 Prospect Ave., S. E., Cleveland, O.
Owen, John, For. B. & B., D. & M. Ry., East Tawas, Mich.

Page, A. A., Div. For. B. & B., B. & M. R. R., Wilmington, Mass.
Palmer, E. F., For. B. & B., B. & M. R. R., Salem, Mass.
Parker, J. F., A. T. & S. F. Ry., San Bernardino, Calif.
Parker, W. V., For. B. & B., St. L. S. W. Ry., Box 358, Paragould, Ark.
Parks, J., 3347 Boulevard F., Denver, Colo.
Parsons, P. E., Asst. Supv. B. & B., O. S. L. R. R., Pocatello, Idaho.
Pauba, A. W., Mast. Carp., C. & S. Ry., Denver, Colo.
Paul, C. E., Prof. Mechanics, Armour Inst. Tech., Chicago.
Peabody, K., Supv. Piers & Bldgs., N. Y. C. R. R., New York City.
Penwell, J. N., Tipton, Ind.
Perkins, H. D., 1501 Walnut St., Danville, Ill.
Perry, C. H., Div. Engr., C. & N. W. Ry, Antigo, Wis.
Pettis, C., Gen. Scale Insp., N. Y. C. R. R., Rochester, N. Y.
Pettis, W. A., Gen. Supv. Bldgs., N. Y. C. R. R., Rochester, N. Y.
Phillips, B. P., Asst. Sup. B & B, N Y N H & H R R, Willimantic, Conn.
Pickering, B. F., Supv. B. & B., B. & M. R. R., Salem, Mass.
Pickering, F. M., Trainman, B. & M. R. R., Salem, Mass.
Pickles, J. L., Div. Engr., D. W. & P., West Duluth, Minn.
Pierce, Roy, Mast. Carp., Erie, R. R., Salamanca, N. Y.
Pinson, J. F., Asst., Engr. B. & B., C. M. & St. P. Ry., Seattle, Wash.

Piper, E. B., Supv. B. & B., B. & M. R. R., No. Adams, Mass.
Plank, D. E., Supv. B. & B., Pac. Elec. Ry., Los Angeles, Calif.
Pollard, Harry, Asst. Gen. Br. Insp., S. P. Co., San Francisco, Calif.
Pollock, H. H., Mast. Carp. of Bldgs., P. C. C. & St. L. Ry., Carnegie, Pa.
Porter, Geo. F., Engr., Const., St. Lawrence Br. Co., Montreal, Que.
Porter, John W., Ch. Engr., Hudson Bay Ry., The Pas, Manitoba.
Porter, L. H., Box 35, Andover, Conn.
Post, J. C., For. B. & B., L. A. & S. L. R. R., Los Angeles, Calif.
Potter, A. K., Insp., C. & N. W. Ry., Antigo, Wis.
Potts, J. O., M. of W. Insp., B. & O. R. R., Baltimore, Md.
Powell, C. E., Gen. Insp. Brgs., C. & O. Ry., Hinton, W. Va.
Powers, G. F., Powers-Thompson Const. Co., Joliet, Ill.
Purdy, G. A., Supv. B. & B., M. K. & T. Ry., Denison, Tex.

Quinn, William, Supt. B. & B., St. L. S. W. Ry., of T., Tyler, Tex.

Rankin, W. F., Mast. Carp., Penn. Lines West, Cambridge, O.
Rask, A. G., Supt. B. & B., C. St. P. M. & O. Ry., St. Paul, Minn.
Ratliff, W. L., Supv. B. & B., I. C. R. R., McComb, Miss.
Rawson, C. P., Archt., C. M. & St. P. Ry., Chicago.
Ray, G. T., Supv. B. & B., St. J. & G. I. R. R., Marysville, Kans.
Rear, G. W., Gen. Insp., S. P. Co., San Francisco, Calif.
Redfield, J. A. S., Div. Engr., C. & N. W. Ry., Fond du Lac, Wis.
Reed, Wm., M. of W. C., Mo. Pac. R. R., McGehee, Ark.
Rees, Edw., Br. Insp., L. I. R. R., Jamaica, N. Y.
Rehmert, D. L., Mast. Carp., Penn. Lines W., Bradford, O.
Reid, R. H., Supv. Brgs., N. Y. C. R. R., Cleveland, O.
Replogle, J. S., For. B. & B., Sou. Pac. Co., Oakland, Calif.
Rettinghouse, H., Ch. Engr., C. St. P. M. &. O. Ry., St. Paul, Minn.
Reynolds, A. W., Mast. Carp., P. R. R., Jersey City, N. J.
Reynolds, J. V., For. B. & B., Mo. Pac. R. R., McGehee, Ark.
Reynolds, J. W., Carp. For., O. S. L. R. R., Pocatello, Idaho.
Rich, B. D., Painter For., Sou. Pac. Co., Stockton, Calif.
Richards, G. T., Storekeeper, C. M. & St. P. Ry., Tomah, Wis.
Richardson, R. W., Div. Engr., C. & N. W. Ry., Sioux City, Iowa.
Ridgway, Arthur, Asst. Ch. Engr., D. & R. G. R. R., Denver, Colo.
Riney, M., Supv. B. & B., C. & N. W. Ry., Baraboo, Wis.
Rintoul, D. T., Gen. For. B. & B., Sou. Pac. Co., Bakersfield, Calif.
Rivers, H. B., Ch. Carp., C. M. & St. P. Ry., Deer Lodge, Mont.
Roberts, A. C., Supv. B. & B., Mo. Pac. R. R., Monroe, La.
Roberts, H. W., Mast. Carp., P. R. R., Erie, Pa.
Robinson, A. W., Div. Engr., O. S. L. R. R., Pocatello, Idaho.
Robinson, J. S., Div. Engr., C. & N. W. Ry., Chicago.
Robinson, John, Supv. B. & B., P. M. R. R., Grand Rapids, Mich.
Robinson, R. B., Engr. M. of W., U P. R. R. Omaha, Neb.
Rodman, G. A., Gen. Supv. B & B, NY NH & H RR, New Haven, Conn.
Rogers, W. A., Civil Engr., 37 W. Van Buren St., Chicago.
Rohbock, W. L., Ch. Engr., W. & L. E. R. R., Cleveland, O.
Rohr, E. J., Asst. Br. Supv., C. & O., 2192 Shadwell St., Cincinnati, O.
Rose, Norman, Supv. B. & B., Sou. Pac. Co., Portland, Ore.
Rose, W. M., For. W. S., Sou. Pac. Co., Sacramento, Calif.
Ross, William, C. M. & St. P. Ry., Millbank, S. D.
Rounseville, D., Asst. to Ch. Engr., C. & N. W. Ry., Chicago.
Roy, C. M., Gen. Br. For., L. & N. R. R., Birmingham, Ala.
Ruge, Aug., Supv. B. & B., C. St. P. M. & O. Ry., Mankato, Minn.
Runyon, C. C., For. B. & B., Mo. Pac. R. R., Gorham, Ill.
Rykenboer, E. J., Supv. Bldgs., N. Y. C. R. R., Rochester, N. Y.

Sampson, G. T., C. E., N. Y. N. H. & H. R. R., (retired), Medford, Mass.
Sattley, R. C., Valuation Engr., C. R. I. & P. Ry., Chicago.
Sayles, H. H., For. B. & B., St. L. & S. F. R. R., Cape Girardeau, Mo.

Schall, F. E., Br. Engr., L. V. R. R., Bethlehem, Pa.
Scheetz, F. B., Dept. Valuation, I. C. C., Kansas City, Mo.
Schoolcraft, C. S., For. Brgs., C. Vt. R., Farnham, Que.
Schuessler, W. B., Supv. B. & B., N Y N H & H R R, Waterbury, Conn.
Scott, Chas., Supv. B. & B., B. R. & P. Ry., Salamanca, N. Y.
Scott, C. E., Eng. Brgs., M. C., Detroit, Mich.
Scribner, C. J., Scale Supvr., C. B. & Q. R. R., Chicago.
Secord, Fred, For. B. & B., Sou. Pac. Co., Sacramento, Calif.
Sedmoradsky, C., For. B. & B., C. St. P. M. & O. Ry., Worthington, Minn.
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Sellew, W. H., Valuation Dept., M. C. R. R., Detroit, Mich.
Settle, T. H., Gen. For. B. & B., S. P. Co., Los Angeles, Calif.
Shane, A., Box 71, Indianapolis, Ind.
Shanklin, F. E., Gen. For., C. & N. W. Ry., Belle Plaine, Iowa.
Sharp, J. S., R. M., Sou. Ry., Hattiesburg, Miss.
Sharpe, D. W., 25 Wooster Place, New Haven, Conn.
Shealy, H. C., Mast. Carp., S. A. L., Hamlet, N. C.
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Shope, D. A., 926 O St., Fresno, Calif.
Shropshire, W., Supv. B. & B., Y. & M. V. R. R., Greenville, Miss.
Sibley, C. A., Engr. & Contr., 902 Chapel St., New Haven, Conn.
Siefer, F. M., Div. Engr., Sou. Pac. Co., Sacramento, Calif.
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Walker, I. O., 1034 Piedmont Ave., Atlanta, Ga.
Wallenfelsz, J., Br. Insp., P. R. R., 501 N. 6th St., Cambridge, O.
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Whitlock, L. M., Asst. For. B. & B., Mo. Pac. R. R., McGehee, Ark.
Whitmee, G. Y., For. W. S., P. M. R. R., Grand Rapids, Mich.
Whitney, W. C., Sen. Archt., I. C. C., 1907-15th St. N. W., Wash., D. C.
Wicks, Warren, Gen. For., L. I. R. R., Amityville, N. Y.
Wilkinson, J. M., Supv. B. & B., C. N. R. R., Van Wert, O.
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Wilson, J., Supv. B & B., G. T. Ry., Hamilton, Ont.
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Wilson, W. W., Div. Engr., G. C. & S. F. Ry., Cleburne, Tex.
Winter, A. E., C. E., 257 Cathedral Pl., St. Paul, Minn.
Winter, J. L., Mast. Carp., S. A. L. Ry., Waldo, Fla.
Wise, E. F., 207 Clay St., Waterloo, Iowa.
Wishart, J. J., Supv. B. & B., N. Y. N. H. & H. R. R., Boston, Mass.
W'tt, C. C., Dist. Engr., I. C. C., 1020 McGee St., Kansas City, Mo.
Wolf, A. A., Ch. Carp., C. M. & St. P. Ry., Milwaukee, Wis.
Womeldorf, C. F., Div. Engr., C. & N. W. Ry., Norfolk, Neb.
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Wood, J. W., Gen. For. B. & B., A. T. & S. F. Ry., San Bernardino, Calif.
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Wright, C. W., Mast. Carp., L. I. R. R., Jamaica, N. Y.
Wright, G. A., Gen. For. B. & B., Ill. Trac. Sys., Decatur, Ill.
Wuerth, H., Asst. Engr., C. M. & St. P. Ry., Chicago.

Yappen, Adolph, Asst. Engr. Br. Maint., C. M. & St. P. Ry., Chicago.
Yates, J. P., Gen. For. B. & B., N. O. T. & M. R. R., DeQuincy, La.
Yereance, W. B., G. M., 8th Ave. R. R., 825 8th Ave., New York City.
Young, R. C., Ch. Engr., L. S. & I. Ry., Marquette, Mich.

Zenor, D., Supv. B. & B., L. & A. Ry., Stamps, Ark.
Zinsmeister, E. C., Mast. Carp., B. & O. R. R., Newark, O.
Zorn, J. F., For. B. & B., Pac. Elec. Ry., Los Angeles, Calif.

Total number of members 775.

Total Number of Members, Jan. 1, 1919,		723
Died,	11	
Resigned and dropped,	17	28
Number of members Oct. 20, 1919,		695
New members Oct., 1919,		80
Total members Oct. 23, 1919,		775

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(For Addresses See Membership Directory)

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Gooch, C. W.
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Hanks, G. E.
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Mackenzie, W. B.
McLean, Neil
McIver, B. T.
Mountain, G. A.
Parks, Jas.
Porter, L. H.,
Ross, Wm.
Shane, A.,
Snow, J. P.
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Wise, E. F.

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Brantner, Z. T.
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Causey, T. A.
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Danes, W. S.
DeMars, James
Dunlap, H.
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Forbes, Jno.
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Heflin, R. L.
Henson, H. M.
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Holmes, H. E.
Hubley, John
Humphreys, Thos.
Isadell, L. S.
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Lamb, C. W.
Lanning, W. R.
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McMahon, Geo.
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Millner, S. S.
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Morgan, T. H.
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Patterson, S. F.
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Redinger, C. A.
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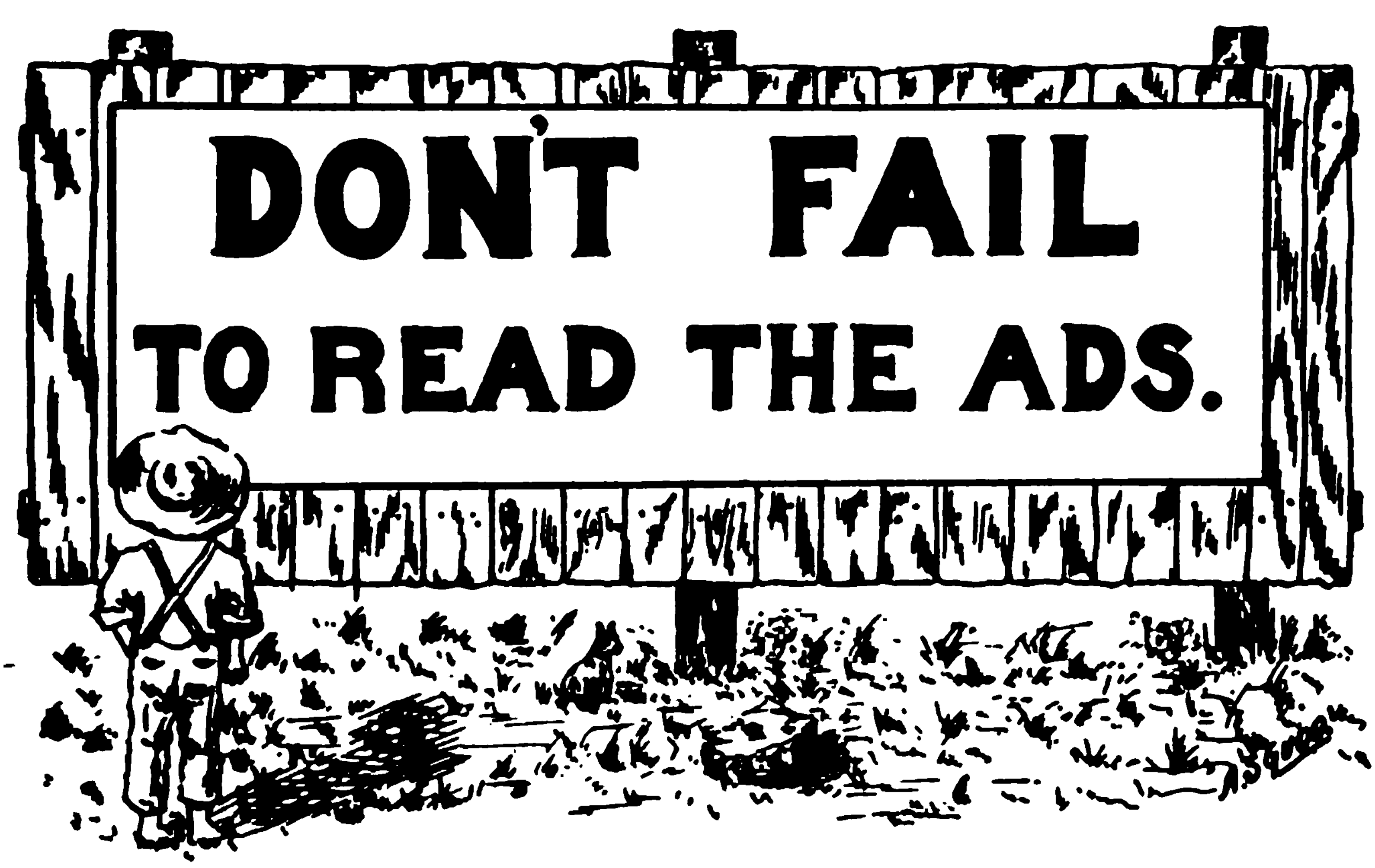

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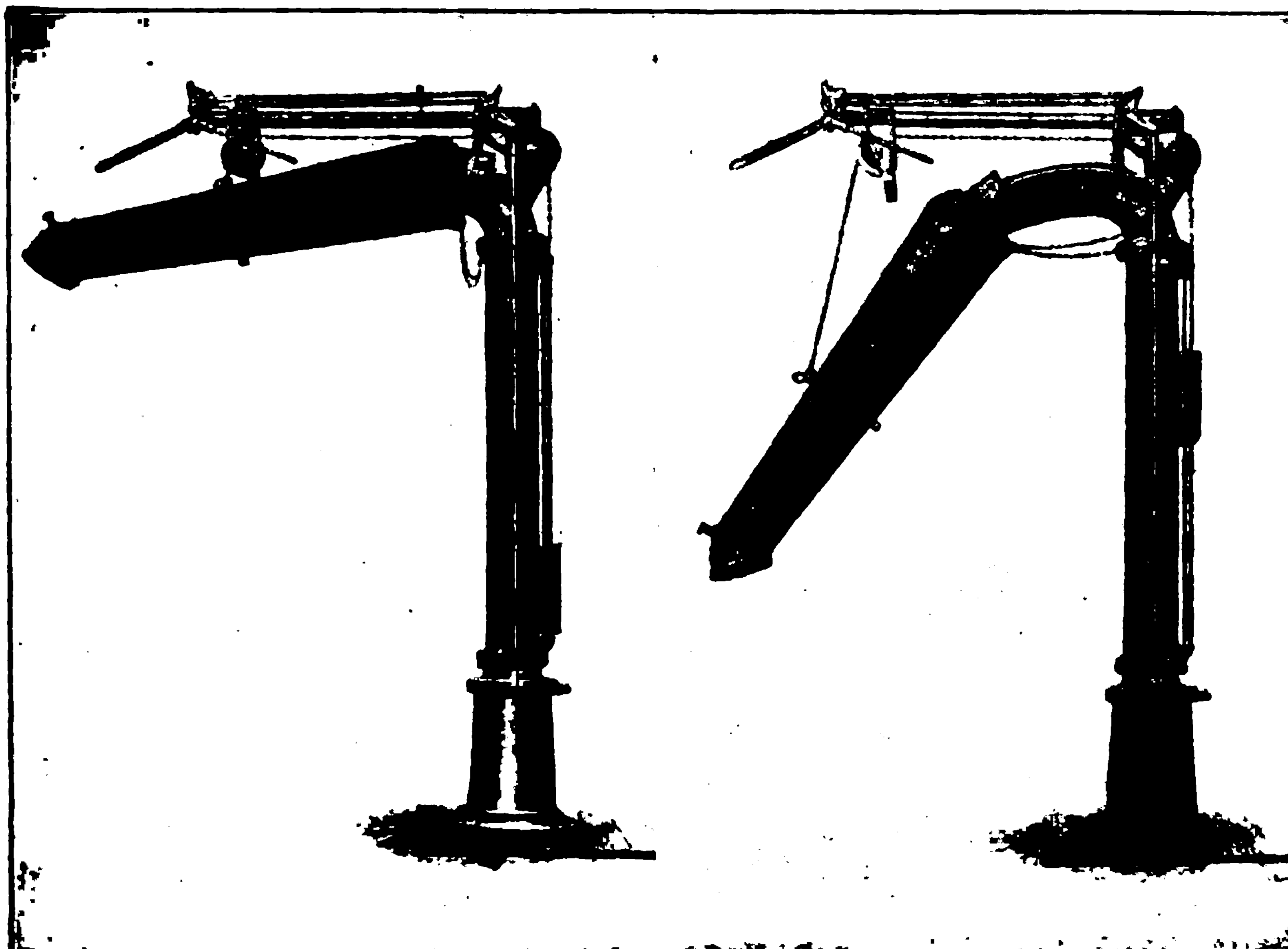

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J. A. Hutchens, Gen. For. W. S., Sou. Pac. Co., Ogden, Utah.
E. H. Johnson, For. Plumb., Erie R. R., Elmira, N. Y.
W. E. Keir, Gen. For. W. S., A. T. & S. F. Ry., San Bernardino, Calif.
J. Mellgren, For. W. S., C. & N. W. Ry., Eagle Grove, Iowa.
Wm. Smith, For. W. S., Mo. Pac. R. R., McGehee, Ark.
G. Y. Whitmee, For. W. S., P. M. R. R., Grand Rapids, Mich.

Cleaning of Structural Steel Before Painting.

Chas. Ettinger (Ch.), Gen. Ptr. For., I. C. R. R., Chicago, Ill.
E. S. Airmet, For. Ptr., O. S. L. R. R., Salt Lake, Utah.
O. F. Dalstrom, Br. Engr., C. & N. W. Ry., Chicago, Ill.
F. O. Draper, Supt. Brgs., I. C. R. R., Chicago, Ill.
H. H. Harman, Engr. Brgs., B. & L. E. R. R., Greenville, Pa.
H. R. Leonard, Engr. B. & B., P. R. R., Philadelphia, Pa.
C. R. Lyman, For. Brgs., C. Vt. Ry., Waterbury, Vt.
R. E. Miller, Br. Engr., St. L. & S. F. Ry., St. Louis, Mo.
John O'Connell, Ptr. For., B. & A. R. R., Pittsfield, Mass.
B. D. Rich, Ptr. For., S. P. Co., Stockton, Calif.

Construction and Maintenance of Cinder Pits.

G. K. Nuss (Ch.), Gen. For. B. & B., D. M. & N. Ry., Proctor, Minn.
C. L. Beeler, Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
W. M. Cardwell, Supv. B. & B., W. T. Co., Washington, D. C.
H. A. Gerst, Asst. Br. Engr., G. N. Ry., St. Paul, Minn.
A. E. Kemp, For. B. & B., L. V. R. R., Hazelton, Pa.
W. L. Rohbock, Ch. Engr., W. & L. E. R. R., Cleveland, Ohio.
F. E. Schall, Br. Engr., L. V. R. R., Bethlehem, Pa.
E. R. Wenner, Supv. B. & B., L. V. R. R., Ashley, Pa.
J. P. Wood, Supv. B. & B., P. M. R. R., Saginaw, Mich.

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Geo. W. Rear, Gen. Br. Insp., S. P. Co., San Francisco, Calif.
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A. W. Robinson, Div. Engr., O. S. L. R. R., Pocatello, Idaho.
C. S. Thompson, Engr. B. & B., D. & R. G. R. R., Denver, Colo.
J. W. Wood, Gen. For. B. & B., A. T. & S. F. Ry., San Bernardino, Cal.

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Publications

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F. E. Weise, Ch. Clk. Engr. Dept., C. M. & St. P. Ry., Chicago, Ill.

Obituaries

P. J. O'Neill (Ch.), Mast. Carp., N. Y. C. R. R., Adrian, Mich.
G. W. Rear, Gen. Br. Insp., S. P. Co., San Francisco, Calif.

Arrangements

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A. W. Reynolds, Mast. Carp., P. R. R., Jersey City, N. J.
H. C. Keith, Const. Engr., 13 Park Row, New York, N. Y.

Proceedings of the Thirtieth Annual Convention

of the

American Railway Bridge and Building Association

Held at

Atlanta, Georgia, October 26-28, 1920

The thirtieth annual convention of the American Railway Bridge and Building Association was called to order in the convention hall of the Piedmont hotel, Atlanta, at 10 a. m., Tuesday, Oct. 26, 1920, by F. E. Weise, president, who called on the secretary to open the convention with prayer.

President Weise:—We are to be especially favored this morning. The mayor of this city has consented to briefly address us and turn over to us the keys of the city, and I take pleasure in introducing to you Mayor James L. Key.

Mayor Key:—The pun which the chairman has just perpetrated is prohibited here on account of the name of this particular mayor, but we will excuse him this time.

We are very happy to get such a splendid convention as this, coming as you do from all parts of the country. You have honored us by your presence here, and we are deeply grateful for it. We think we have a beautiful country. Most of you have journeyed through the country and have had an opportunity of observing some of its beauties. There has been an awful dry spell though (Laughter), and while you have been looking over the landscape I expect you may have been eating some of it. Now I know from experience that while I think our country looks all right, I don't myself think that it tastes quite right.

This city is very much concerned about the railroad and railroad interests. There is scarcely a city in the country which is so dependent upon the railroad activities as this city. We draw

the larger part of our business and activities from the fact that this is a great distributing center. Our whole prosperity is bound up in the prosperity of the railroad interests. We cannot get along without you and the more active and the more prosperous and the better service which you give only adds to the prosperity and the advantage of our own city. I am very glad to have you meet here, because there are but few places in the country where more work is needed along the lines of your particular profession than here. We have a great deal of bridge building and the like of that to be done in this city. The city is anxious to have it done, and we are anxious to have the railroads do it. We will help them some, of course, but you doubtless know from experience that when anything like that is wanted to be done why the communities very gladly coöperate in letting you do it. We will do as well as that or maybe better. Anyhow we are very anxious to have it done.

We hope that we may be able to make you enjoy your stay down here. You will find our people a genial, happy sort of people. They are, in general, hospitable and kindly disposed, and you will find that the greatest pleasure that you could give them would be the opportunity to make you as happy as possible. Our country is a bright, sunshiny country. They tell me that the sun shines half the time and the " moon shines " all the time. I am not so sure about that. (Laughter.) I see that I am informed that such is the case. I have no particular knowledge, but in going around here if you see what you want why take it, and if you don't see what you want, you ask some of these boys about it. (Laughter.) You aren't thinking about the same thing I am thinking about at all. (More laughter.) Anyway, if there is anything that we have here that will contribute to your pleasure and your happiness we will either get it for you or try to get it for you. We hope that you will see fit to meet here often. Nothing you could do gives us more pleasure than to have this splendid association of technical men who are out doing things and building things meet here in Atlanta today, and in behalf of the city and its people I extend to you a most cordial greeting and bid you a most hearty welcome. (Applause.)

President Weise:—Mayor Key, we appreciate your invitation very much and we will be sure to take full advantage of it. I will call on Mr. G. E. Watts to introduce the next speaker.

Mr. G. E. Watts:—Mr. President, Mr. Mayor, Ladies and

Gentlemen,—We thought on this occasion that we should have at least some of our best talent to welcome you good people to our city. I have been active in the arrangements with Mr. Nelson and the rest of your committee that saw fit to make your stay pleasant while you are here, and make you want to come back, and we can only do that by calling on our talent to welcome you to our city, men who are at the head of civic matters, and know the city's interests and activities as do Mayor Key and Mr. Eugene Black, the president of our Chamber of Commerce. I take pleasure in introducing to you Mr. Black. (Applause.)

Mr. Black:—Mr. President, Mr. Watts, Ladies and Gentlemen,—My good friend George Watts telephoned me about a week ago that he wanted me to make this speech, but I didn't know he wanted me to make it just so he could get to introduce me. I appreciate the kind things he has said about me, and I am going to admit they are all true, so we can close that discussion.

My father was in the Confederate army and I recall hearing him say that when they called the roll of the company each morning there was one fellow that always replied, "Here but mighty sick." I just returned this morning from a trip up North, it was too hot up there, and I caught a very bad cold. I am here but mighty sick.

It struck me that the address of the mayor was cordial but not direct or informative. He referred to conditions, but gave no remedy for them. Of course it is not his fault that the country is dry, but as long as it is dry and there is no remedy for it, there is no use referring to it. (Laughter.) I would like to let you folks from all over the country know that so far as his suggestions are concerned, his name is the only thing that gives an index as to what was talked about, and then he didn't mention whiskey.

I have been called on so many times during the past year in my official capacity as president of the Chamber of Commerce with Mayor Key to make addresses at meetings similar to this, that I always anticipate what he is going to say, and I always enjoy it. He is hearty in his welcome and really sincere in being glad to have you ladies and gentlemen here in Atlanta. We welcomed all sorts of conventions this year, ranging from your honorable body to a deaf and dumb association. I think probably the audience that was most appreciative of his efforts and mine

was the deaf and dumb association. It wasn't even interpreted to them, either.

I didn't know exactly what your association did, and the mayor and I never do know until we get to the convention. I find that you are The American Railway Bridge & Building Association, and I have noticed some of the topics which have given me some light on your activities. I see they are devoted to the entertainment of children, ladies and men, so they are all-comprehensive. I see on your program here that your first subject for discussion is "Repair and Maintenance of Tank Hoops." I suppose that is for the pleasure of the children. (Laughter.)

I see the next topic you have on your program is "The Application of Paint by Spraying." You know we claim we have the most beautiful women in the world in the south. That is just because we don't know the northern and the western women as well as we would like to know them. We have always been sort of afraid of them, to tell you fellows the truth. I was up in Oconomowoc, Wis., one night with a lady. There was nothing on earth to do except to tell her how much I loved her,—the moon was shining and the stage seemed to be all set, and it would have been a profligate waste of nature not to have told it. I got through telling her and she said, "I think you better speak to father." Now that is the last thing we do down here; we never speak to father until father speaks to us. (Laughter.) Our ladies are not only beautiful, but they are proficient and they are efficient. We don't risk them much with cooking, but in other lines they are proficient and efficient, and they have also taken up this thing of painting to some extent. They have proven their artistic temperament in large degree, and they go on the theory that anything that adds to their improvement pleases the men, the same theory that a man ought to run his household on, and that is to tell his wife everything that will add to her happiness; let her find the rest out if she is determined to do it. But this doctrine that you are preaching here, this "application of paint by spraying," is going to save a great deal of laborious. tedious effort. I imagine you could just have a sort of a paint shower above the head and let the ladies turn on the spray and they would then be ready for any contingency that might arise during the day. Well, now that is the kind of program to get the ladies out. They have come to the convention, and I imagine

they don't care a thing about trusses and other parts of bridges, if there are other parts.

But you have also been rather comprehensive in your program, because I see you have something for the men. The next subject is "Recent Developments in Concrete (Proper Proportioning of Concrete Mixtures)." Now my idea about concrete, to use a slang phrase, is that it is a mixture that you can't penetrate very well, and you have moved away from the idea of wooden mixtures in manhood to the concrete mixtures, where they are absolutely dense. I take it that that is not applicable to you gentlemen, but that is just put there so as to make you a part of the program. I wish I might stay here during all your sessions. I would especially like to stay with the ladies while they are trying the paint spray.

We have a very busy city here, however, a city that demands our time, demands our best efforts in trying to upbuild it, so I won't be able to hear these different subjects discussed, and I have just got to draw my own conclusions from your program. I realize how comprehensive your body is when I note that it is The American Railway Bridge and Building Association. I came down on the train with some of your delegates. One gentleman sitting right before me was from Maine and connected with the Maine Central railroad. That gave me an idea of how far from home people come in order to take a part in these conventions. I see that the program has been partially mapped out for you and that during your stay you are going to Grant Park and that you are going voluntarily to the federal prison. I want to say further that insofar as Grant Park is concerned you gentlemen will all enjoy the cyclorama there that depicts the battle of Atlanta. It is drawn by a southern painter and you can imagine the result of the canvas. You know they burned Atlanta in '61 and '65, so everything you see here is brand new. But you will like that picture and some of you older men will have your blood stirred again, and, if you are a deep student of history you will remember how we worked you back yonder in '61 and '65. But so far as we are concerned it is all forgotten, and we hope we are forgiven. (Applause.)

Now out at the federal prison you are going to find really one of Atlanta's institutions. We get a little aid from the Federal government in running it, and you concrete mixers will be very much interested in the wall out there. How they ever got

the convicts to give their consent to building that immense wall I don't know. I will be very glad while any of you are out there, too, if you will give my regards to any of your friends that may be there. (Laughter.)

Now I join the mayor in hoping that you will enjoy your stay here in Atlanta. We are really all perfectly happy to have you here. We want you to go all over our city; we want you to see it; we want you to enjoy it, and we want you to go back home and tell the folks at home about it. You must remember that we really are a rather young city, that we went through the days of reconstruction, and when I hear talk in Europe about this subject and the need of outside aid, the need of the world going in to help them reconstruct, I think the efforts of our own country and the progress that it made during those days is an example that you have got to reconstruct at home, and that when you go at the task the materials that are necessary are the spirit and the indomitable will and energy of the men at home in reconstructing their own country.

We have a lot of railroads here and a great many bridges. We have some good bridges. They are always good until something happens to them, though; you men know that. A bridge is perfectly safe until it falls down. I represent two or three railroads, and I have really had to prove that a bridge was good after it fell down. It is not difficult to do that if you have a good line of wit. It is a little difficult sometimes to make a jury believe it, but you can prove it, whether they believe it or not. (Laughter.)

We have here in Atlanta a Chamber of Commerce with 3,300 members that unselfishly devotes itself to the interests of Atlanta and to the interests of the community. We have in addition to that some 80 other civic organizations, and every single one of them is devoted to the interests of the city and in trying to build it up.

We are the second largest mule market in the world. We have more mules here in Atlanta than anywhere except in St. Louis. We are the third largest insurance center of the United States. I am not going to tell you much more business. I am going to let you find it out. If any of you fellows feel provincial or need aid and guidance, just call on an Atlanta citizen and he will show you around. I would like to give you a sort of personal welcome to Atlanta. I would like to have you feel that

Atlanta is personally interested in your business. I would like for you to feel that we are glad you are here, and that if you don't have a good time in Atlanta you are not going to be as sorry about it as we Atlantans are.

They talk a good deal about southern hospitality. It is not different from the hospitality of any other section. Western hospitality is just the same, and northern hospitality—when they exercise it—is just the same. (Laughter.) And eastern hospitality is just the same. We are all one great big country, and if we haven't learned through the sacrifice and the millions that we expended in showing that America was one united country, working to one end, and that was to make the world a better world to live in, then the sacrifice and the cause of the last three years has been a wasted sacrifice and a wasted cause. We have the same kind of hospitality here that you have at home, just exactly, no better, no worse. We want you more than anything else to enjoy yourselves, and then we want you to take a good impression home with you and spread that impression.

I am very glad on behalf of the city to welcome you to Atlanta. (Applause.)

President Weise:—I will call on E. T. Howson to make a response in behalf of the association

E. T. Howson:—Mr. President, Mayor Key, Mr. Black, when we decided a year ago to come to Atlanta, we had heard much of the southern hospitality. About 11 years ago, I think it was, we met in Jacksonville, and this is the second time that this association has met in Atlanta, the first time being 19 years ago. A few of the members now present were here then. Most of us are here as members of the association for the first time. We have looked forward to this meeting, not alone for the technical work which will be done, but for the many nice things we have heard about this city. The mayor and Mr. Black have started us on the realization of those pleasures in several ways. They have touched on things that interest the men and the ladies of this association, of the city and its charms, on the railway interests of the roads that center in Atlanta,—this metropolis of the southeast. We are coming in this meeting as the first convention since the railways on which the members of this association are employed have come back into private control. The men in this association are now planning the work of reconstruction, following the trials of war, the excessive burdens placed on the

roads, and the neglect that was necessary while we were concentrating on the one big problem, that of winning the war.

The railways in the south have a large amount of work to do. The railways all over the country have, but the south, of which this city is the metropolis, is now in an era of tremendous development. Your new station is an indication of the way in which the railways are appreciating the needs of the south as a transportation center. The rapid growth of your city I think we may safely say, as the mayor has touched on, is largely due to the possibilities as a transportation center; an inland city such as this is dependent on the railways, and the railways are dependent, likewise, on Atlanta. Therefore the members of this association who gather here come to promote economic, efficient practices on the railways, and they believe that the program which you have touched on will contribute to that end.

I think, Mr. President, that Mr. Black's interpretation of the program has given us some new thoughts for this association. Perhaps we have been a little narrow in our practices, a little narrow in the way we have developed our committee reports. and I think we are going to need a larger hall when we get into some of these discussions. I think he has very well advertised one report, at least, which will draw an increased crowd. If we do nothing more at this convention than to get that idea of a broader application of bridge and building work such as painting, we will have gone a long way in making this convention more worth while.

I am sure that I speak for the members of this association and the members of their families in saying that we appreciate the welcome that has been extended to us officially by the government of the city of Atlanta, through its mayor, and by its commercial organization through its president. We shall enjoy our stay here; we shall take advantage of it to see Atlanta, to see its charms, to see things which we have heard about, and I know we are going to carry a pleasant recollection of this convention back to our friends and our associates in various parts of the country. We do appreciate the welcome you have extended to us. (Applause.)

President Weise:—It is customary at this point for the president to take up a little of your time, but I will promise to be brief.

PRESIDENT'S ADDRESS

We are assembled this morning to commemorate the 30th anniversary of the organization of the American Railway Bridge and Building Association and it is my pleasure and privilege to accord you a most hearty greeting. We were assured a year ago that we would receive a royal welcome at Atlanta and we have not been disappointed. On the trains as we traveled toward this city and on our arrival, have we had evidence of true southern hospitality and the reputation of the south has again been sustained. Everything that could be done to anticipate our needs has been provided and the committee on arrangements deserves every commendation for the good work it has done.

Our association has been in existence for three decades and this in itself is evidence of the careful planning and thorough work done by its organizers. The work they started is now being carried on by another generation, but so well were the foundations laid that we have had no occasion to deviate from the principles which they established.

It is very gratifying to be able to make the same report that all past presidents were able to make that the affairs of our association are in a splendid and prosperous condition. This is due in large measure to the fine work that is being done by our secretary who is always on the alert and relieves the president of much worry and detail. Without trying to make it embarrassing for him, I wish at this time to express my personal appreciation of his work. I have learned during the past year something of the amount and character of his duties and can assure you that it could only be carried on by one who has the interests of the association truly at heart.

The total membership at the close of our last meeting was 776 and the membership committee has an unusually long list of applications to present this morning. The record shows a steady increase in membership and what is more the interest in the association is increasing in an even greater ratio. Very encouraging expressions have come from railroad officials all over the country, indicating their interest in and approval of our work. The number of members who have taken upon themselves the duties and responsibility of officers or members of committees is 115. This is a good percentage of the enrollment but does not represent the active working force because hundreds of others have been called upon and have contributed to our work.

Since our last meeting the railroads of the United States have passed from Federal to private control and this change following war conditions is attended by many serious problems. Much has been said and written about the present situation and many men prominent in railway circles have expressed their views as to the greatest needs of the railroads. Their opinions vary because the needs of the roads they are connected with are not all the same, but there is one thought that they appear to share in common, and that is the need of improved morale of railway men. We are loath to admit that there has been a letting down of the loyalty and efficiency of railway employés, but must face the facts, and our problem is, what are we going to do about it? The railroads of the country are now passing through a crisis and whether they do it successfully or not will depend in large measure upon the faithfulness and loyalty of officials and employés. It is incumbent upon every member of this association to not only be faithful and loyal himself, but to do all in his power to inculcate these qualities in those working under his direction and those with whom he comes in contact. Concerted effort in this direction cannot fail to strengthen the morale of the entire organization.

We are now at the beginning of what we are pleased to call the period of reconstruction. Because of the war and its effect on all lines of industry much needful work has been postponed until we are facing

a large accumulation of new work that is constantly becoming more urgent. The conditions referred to have also developed a labor and material situation for which we have no precedent, and there is need for great care and watchfulness in handling our work. In the past railroads have been built and developed in advance of the development of the country and as speed in construction as well as low first cost was a leading factor in this work, the larger percentage of railroad structures were built of wood and are in reality temporary structures. As the country developed and the resources of the roads permitted, the temporary structures were replaced by permanent ones, but the former are still in the majority. Under present conditions the cost of labor is so large a part of the cost of a structure that the variation in the cost of materials forms only a small percentage of the total cost and therefore more consideration is being given to the serviceable life of the material with a view to keeping down maintenance costs. It is thus of a decided advantage to build better and more permanent structures, gradually working toward that time when all railroad structures shall be of permanent construction. Railway officials who have traveled in France and other European countries call attention to the fact that there are no wooden bridges or other structures on the right of way of the railroads and that everything is of steel or concrete.

During recent years the railroads of our country have been unable to keep pace with the development of other industries. For that reason extensions of lines into new territory will be rather limited and more attention will be paid to the perfection of present lines with more definite planning for the future. Much will be brought out in our meeting to emphasize this.

Our committees have done most excellent work this year and of this you will soon have evidence. It is regretted that it was impossible to get the reports printed for advance distribution. I wish at this time to thank all those who so generously contributed of their time and effort to make our reports a success. Your president has made so many requests during the year and has met with such hearty response that he is persuaded that the slogan of this association is "Ask and you shall receive."

As we are gathered here this morning we are saddened because we miss a number of familiar faces. During the year our Heavenly Father has seen fit to call home 10 of our members. Aaron S. Markley, a charter member and one of the committee that drafted our constitution and by-laws; Joseph H. Cummin, who joined the association at its second meeting and will always be remembered by us for his beautiful opening prayers, and B. F. Pickering, who became a member at the eighth meeting. These three men were presidents while our association was yet young; they took an active interest in all our affairs, were regular in attendance and leaders in discussion. Cyrus P. Austin of the Boston & Maine, who became a member at the fourth meeting and served several years as treasurer; J. S. Berry of the St. Louis Southwestern, who joined at the third meeting; Alf Brown of the Pacific Electric, W. H. Moore of the New York, New Haven & Hartford, C. F. Flint of the Central Vermont, Geo. McMahon of the Southern Pacific, and P. E. Parsons of the Oregon Short Line.

We shall miss these men and their families while we honor them for their work in the association and for their integrity and uprightness as faithful and loyal railroad men.

Our association is increasing rapidly in numbers and naturally we need to make some modifications of our organization from time to time. A committee was therefore appointed soon after our last meeting, delegated with the task of revising our constitution and by-laws. You have been advised of their recommendations and will be called upon to pass on them, but you will note that the changes that seemed needful are only minor ones, so well was the organization planned

30 years ago, together with more recent changes. We have with us today three charter members who were on hand at that first meeting, A. McNab, of the Pere Marquette, J. H. Markley, of the Toledo, Peoria & Western, and C. W. Gooch, the first secretary of the association.

It is a special privilege this morning to extend a greeting to the ladies who have honored us by their presence. We are glad you are here, not only because of the tone and guarantee that your presence lends to our convention, but for your own sakes. You have been repeatedly reminded in the past of your need to act as guardians and restrainers, but let us hope that your past efforts in this uplift work have been so thorough and effective that your duties along these lines will be less arduous and confining and that you will have more opportunity to enjoy this trip for your own pleasure and profit.

Just a closing word to the members and to those who expect to become members. Your officers and committees have spent much time and thought in preparing for this convention. Complete arrangements have been made for your entertainment and everything planned so that you can give undivided attention to our sessions. Committee reports have been carefully prepared and printed and are ready for your consideration. These reports represent much thought and labor and much personal sacrifice on the part of many. The officers and committee members feel that they have paved the way for you and to this extent our work is done. From now on the meetings are in your hands and their success depends upon the good use you make of your time. You are invited to make full use of your opportunities, and judging from previous meetings I am sure you will need no further urging.

President Weise:—I will call on O. T. Nelson and G. E. Watts to give us some word regarding the features of entertainment.

Mr. Nelson and Mr. Watts gave a brief outline and mentioned that a supplementary program would be issued which would set forth all of the features in detail.

Hunter McDonald also gave an outline of the trip to be taken Wednesday afternoon over the terminal of the Nashville, Chattanooga & St. Louis railway.

A short intermission was taken to permit the ladies to retire and order was resumed at 11 : 15 a. m.

President Weise:—I will ask C. R. Knowles to act as assistant secretary during the convention.

The next thing on the program is the reading of the minutes of the last annual meeting. They have been published in our proceedings. Will some one move we dispense with their reading?

Upon motion by J. P. Wood the reading of the minutes was dispensed with, as well as minutes of the executive committee meeting.

The next order of business is the roll call, registration, and collection of dues.

The Secretary:—A desk has been located just outside the

door of the convention hall, in charge of O. J. Hein, where you will find registration cards and where dues may be paid. Badges and identification slips will also be found there.

The registration showed the following members in attendance:

Members Present

N. C. Ailes
L. J. Anderson
Geo. W. Andrews
F. C. Baluss
E. K. Barrett
A. H. Beard
L. Beck
L. M. Blake
S. C. Bowers
C. W. Brown
S. H. Blowers
J. C. Brown
J. E. Buckley
J. M. Caldwell
W. M. Camp
W. M. Cardwell
M. M. Carmody
F. M. Case
W. W. Casey
A. J. Catchot
J. B. Clarke
A. S. Clopton
F. J. Conn
A. C. Copland
M. M. Corrigan
Geo. M. Cota
D. E. Counts
A. M. Dodd
W. O. Eggleston
J. L. Enright
F. A. Eskridge
Chas. Esping
D. D. Everett
R. F. Farlow
J. W. Fletcher
Julius Froese
F. Gable
J. P. Gallagher
W. R. Gantz
A. I. Gauthier
Ira Gentis
E. C. George
H. A. Gerst
O. C. Gongoll
C. W. Gooch
Chas. Gradt
F. N. Graham
F. M. Griffith
Edw. Guild
A. W. Harlow
H. Heiszenbuttel
J. Henderson
R. C. Henderson
F. W. Hillman
Peter Hofecker
W. B. Hotson
B. J. Howay
E. T. Howson
B. M. Hudson
J. Hunciker
J. A. Hutchens
A. J. James
R. E. James
C. H. Johnson
Maro Johnson
W. G. Kemmerer
A. E. Kemp
A. H. King
Thos. H. King
C. R. Knowles
W. V. Lattin
J. S. Lemond
C. A. Lichty
M. J. Loeffler
G. A. Manthey
J. H. Markley
E. M. McCabe
Hunter McDonald
A. G. McKay
H. C. McKee
A. McNab
W. F. Meyers
C. E. Miller
Homer Morgan
O. T. Nelson
G. K. Nuss
J. L. Pickles
R. Pierce
C. E. Powell
V. C. Proctor
C. P. Rawson
Edw. Rees
R. H. Reid
A. W. Reynolds
Arthur Ridgway
M. Riney
H. B. Rivers
J. S. Robinson
Chas. Scott
F. E. Shanklin
J. S. Sharp
H. C. Shealey
J. P. Smallenberger
C. U. Smith
W. A. Spell
Jos. Spencer
J. M. Staten
W. A. Stewart
C. C. Stiver
W. F. Strouse
H. B. Stuart
W. M. Sweeney
A. M. Swenson
S. C. Tanner
J. J. Taylor
J. B. Teaford
M. E. Thomas
Otto C. Till
T. B. Turnbull
C. G. Vollmer
L. J. Wackerle
I. O. Walker
C. F. Warcup
P. N. Watson
Chas. Wehlen
F. E. Weise
F. J. Welch
G. W. Welker
E. R. Wenner
J. C. Williams
J. L. Winter
J. J. Wishart
J. P. Wood
R. C. Young
D. Zenor
E. C. Zinsmeister

The following list of applicants, subsequently elected to membership, were also present:

Wm. J. Azer	C. S. Heritage	G. Montgomery
H. D. Barnes	G. G. Hewitt	T. E. O'Brien
A. P. Bradley	A. B. Ilsley	J. Ostrom
E. L. Cochran	J. W. James	R. E. Price
A. O. Crutchfield	J. A. Johnson	A. B. Scowden
O. H. Czamanske	S. D. Johnson	A. D. Shreve
John S. Ekey	R. J. Jones	L. K. Sorensen
V. E. Engman	J. J. Keggan	M. G. Tribe
H. R. Gibson	E. Kimmel	A. W. Walter
Job. Goodman	A. A. Kurzejka	Harry Wehlen
B. A. Guill	R. P. Luck	W. E. White
H. L. Hatcher	G. M. Mayer	S. R. Young
O. J. Hein	J. K. Melton	

Total number of members registered, 172.

REPORT OF MEMBERSHIP COMMITTEE

Jackson, Mich., Oct. 18, 1920

The membership committee has had a very active season and has the pleasure to report a large number of new names from all parts of the country.

In submitting this report, the committee wishes to take the opportunity to thank the officers and members of the association for their assistance in this work, which they have so freely given.

While it is believed that the ground has been covered very thoroughly this year, there is still a fertile field yet undeveloped, as there are several large railroads which have few or no representatives in our organization.

The following list of applicants is presented for your consideration, and their election to membership is recommended by the committee.

The Committee,

H. A. Horning, Chairman.

New Members

Azer, Wm. J., Supv. B. & B., C. & N. W. Ry., Chicago.
Barnes, H. D., Asst. Engr., C. & N. W. Ry., Chadron, Nebr.
Beatty, L. D., Supv. B. & B., Sou. Ry., Princeton, Ind.
Bechtelheimer, A. E., Genl. Br. Insp., C. & N. W. Ry., Chicago.
Bradley, A. P., Roadmaster, Sou. Ry., Atlanta, Ga.
Brooks, W. H., Supv. B. & B., C. of Ga. R. R., Columbus, Ga.
Brown, J. C., B. & B. Mast., D. & H. Co., Plattsburgh, N. Y.
Bryson, H. L., Mast. Carp., S. A. L. R. R., Hamlet, N. C.
Casserly, N. J., Br. Insp., Sou. Pac. Co., San Francisco, Cal.
Cheatham, S. W., Supv. B. & B., M. & O. R. R., Murphysboro, Ill.
Chesney, O. V., Supv. B. & B., S. P. Co., Portland, Ore.
Cochran, E. L., Br. Supv., Sou. Ry., Atlanta, Ga.
Coffin, J. E., Tim. Exp., Sou. Ry., Winston-Salem, N. C.
Cookingham, J. F., Mast. Carp., C. & E. I. R. R., Danville, Ill.
Cothran, J. M., Supv. B. & B., Sou. Ry., Rock Hill, S. C.
Crutchfield, A. O., Br. For., L. & H. R. R., Knoxville, Tenn.
Czamanske, O. H., Ch. Carp., C. M. & St. P. Ry., Portage, Wis.
De Armond, Roy., Br. Insp., Sou. Pac. Co., Bakersfield, Cal.
Demmon, H. R., Fire & Tunnel Insp., S. P. Co., Portland, Ore.
Denz, L. J., Ch. Carp. C. M. & St. P. Ry., Chicago.
Derham, H. M., Asst. Engr., O. S. L. R. R., Pocatello, Idaho.
Doyle, Peter, Supv. B. & B., G. T. Ry., Montreal, Que.

Eberst, Paul, For. B. & B., K. & M. R. R. Middleport, O.
Eggert, Henry, Ch. Carp., C. M. & St. P. Ry., Milwaukee, Wis.
Ekey, John S., Supv. Strs., B. & L. E. R. R., Greenville, Pa.
Engman, V. E., Ch. Carp., C. M. & St. P. Ry., Montevideo, Minn.
Fairchild, D., Supv. B. & B., N. P. Ry, Seattle, Wash.
Ferguson, J. G., Bridge Insp., S. P. Co., Dunsmuir, Calif.
Figg, F. M., Asst. Engr., C. & N. W. Ry., Escanaba, Mich.
Gehrig, A. G., 4529 Fifth Ave., Los Angeles, Calif.
Gibson, H. R., Div. Engr., B. & O. R. R., Connellsville, Pa.
Gilkey, R. H., Supv. B. & B., C. of Ga. R. R., Savannah, Ga.
Glass, J., Gen. For. Snow Sheds, S. P. Co., Donner, Calif.
Goodman, Job., Supv. B. & B., Sou. Ry., Winston-Salem, N. C.
Graburn, H. R., Desig. Dftsman., Erie R. R., Hornell, N. Y.
Granfield, W., Br. Inspr., Sou. Pac. Co., Sacramento, Calif.
Gregory, Neal, Ch. Carp., C. M. & St. P. Ry., Milwaukee, Wis.
Guill, B. A., Supv. B. & B., Ga. R. R., Camok, Ga.
Guyton, S. W., Mast. Carp., Pa. Lines W., Logansport, Ind.
Hatcher, H. L., Mast. Carp., S. A. L. R. R., Americus, Ga.
Hein, O. J., Draftsman, C. & N. W. Ry., Chicago.
Henley, L., Genl. Br. For., S. A. L. R. R., Waldo, Fla.
Heritage, C. S., Br. Engr., K. C. S. Ry., Kansas City, Mo.
Hewitt, G. G., Supv. B. & B., Sou. Ry., Greensboro, N. C.
Hinkle, C. L., Asst. Mast. Carp., Erie R. R., Youngstown, O.
Ilsley, A. B., Engr. Brgs., Sou. Ry., Charlotte, N. C.
James, J. W., Supv. B. & B., N. O. G. N. R. R., Bogalusa, La.
Johnson, J. A., Br. Supvr., Sou. Ry., Atlanta, Ga.
Johnson, H. C., For. B. & B., Sou. Pac. Co., Bakersfield, Cal..
Johnson, S. D., Supvr. B. & B., Sou. Ry., Knoxville, Tenn.
Jones, H. C., Brg. Insp., Sou. Pac. Co., Portland, Ore.
Jones, J. W., Supv. B. & B. & R. M., Sou. Ry., Portsmouth, Va.
Jones, R. J., Roadmaster, Sou. Ry., Columbus, Ga.
Keggan, J. J., Mast. Carp., Erie R. R., Marion, O.
Kimmel, E., Asst. Archt., Sou. Ry., Charlotte, N. C.
Kurzejka, A. A., Ch. Carp., C. M. & St. P. Ry., Minneapolis.
Lowdermilk, T. T., Mast. Carp., P. R. R., Sunbury, Pa.
Luck, R. P., Asst. Engr., C. & N. W. Ry., Chicago.
Luxton, J. F., Supv. W. S., P. M. R. R., Saginaw, Mich.
Masters, F. H., Asst. Ch. Engr., E. J. & E. R. R., Joliet, Ill.
Mauney, J. L., Supv. B. & B., Sou. Ry., Greenville, S. C.
Mayer, G. M., Mast. Carp., S. A. L. R. R., Atlanta, Ga.
McDougall, G. W., Div. Engr., M. of W., S. P. Lines, Mazatlan, Sin., Mex.
Melton, J. K., Photog., I. C. R. R., Chicago.
Montgomery, Geo., Ptr. For., G. T. Ry., Stratford, Ont.
Morrison, L. P., Supt. W. S., P. M. R. R., Saginaw, Mich.
Neville, E. C., Supv. B. & B., G. T. R., Allandale, Ont.
O'Brien, T. E., B. & B. Mast., D. & H. Co., Carbondale, Pa.
O'Connor, J. F., For. W. S., C. & N. W. Ry., Chadron, Nebr.
Olson, A., Supv. B. & B., C. & N. W. Ry., Shoshoni, Wyo.
O'Neil, J. W., Supt. B. & B., T. & O. C. Ry., Thurston, O.
Ostrom, John, Ch. Carp., C. M. & St. P. Ry., Wabasha, Minn.
Pinard, T. W., Asst. Ch. Eng., M. of W. P. R. R., Chicago.
Plummer, H. M., Genl. Br. For., S. A. L. R. R, Manatee, Fla.
Price, R. E., Supv. B. & B., Sou. Ry., Knoxville, Tenn.
Redd, G. L., For. B. & B., Pac. Elec. Ry., Los Angeles, Calif.
Reister, W. W., Supv. B. & B., Sou. Ry., Asheville, N. C.
Scowden, A. B., Asst. Engr. Brdgs., B. & O. R. R., Cincinnati, O.
Seay, A. G., Supt. W. S., S. A. L. R. R., Waldo, Fla.
Shreve, A. D., Div. For. Bldgs., N. Y. N. H. & H. R. R., Providence, R. I.
Sistrunk, R. W., Div. Engr., L. & N. R. R., Bay St. Louis, Miss.
Sitton, G. L., Engr. M. of W., Sou. Ry., Danville, Va.
Smith, A. J., Mast. Carp., C. & E. I. R. R., St. Elmo, Ill.

Smith, S. R., For. B. & B., Sou. Pac. Co., Sacramento, Calif.
Smith, W. L., Br. Engr., Term. R. R. Assn., St. Louis, Mo.
Solan, P. F., Supv. Bldgs., N. Y. C. R. R., New York City.
Sorensen, L. K., Ch. Carp., C. M. & St. P. Ry., Harlowtown, Mont.
Stang, Thos., Supv. B. & B., N. P. Ry., Jamestown, No. Dak.
St. Clair, Oren, For. B. & B., T. & O. C. Ry., Kenton, O.
Stearns, J. H., Mast. Carp., C. R. I. & P. Ry., El Reno, Okla.
Stevens, C. M., Fire & Tunnel Insp. S. P. Co., Portland, Ore.
Strain, J. H., For. B. & B., Sou. Pac. Co., Marysville, Calif.
Tribe, M. G., Mast. Carp., Erie R. R., Elmira, N. Y.
Turnbull, W. W., For. Ptr., G. T. R., Allandale, Ont.
Van Ingen, D. K., Div. Engr., C. & N. W. Ry., Chadron, Nebr.
Veith, T. E., Supv. B. & B., Sou. Ry., Huntingburg, Ind.
Walden, W. H., Roadmaster, Sou. Ry., Richmond, Va.
Walter, A. W., Mast. Carp., B. & O. R. R., Weston, W. Va.
Wehlen, Harry, M. of W. Clerk, L. I. R. R., Jamaica, N. Y.
West, B. E., Asst. Supv. B. & B., Sou. Ry., Barboursville, Va.
Wetzel, J., Brg. Insp., Sou. Pac. Co., Portland, Ore.
White, W. E., Asst. Gen. For., A. T. & S. F. Ry., Chanute, Kans.
Young, S. R., Asst. Ch. Engr., Ga. R. R., Atlanta, Ga.

Total No. of new members 103.

Moved that the secretary cast a single ballot electing to membership the entire list of applicants and to include all those whose names are presented during the convention which are passed upon by the membership committee. Motion carried.

REPORT OF THE SECRETARY-TREASURER

We meet in this convention under more favorable auspices than any year since the world war began. We have all been crowded to the limit with work during recent years and it has been difficult to keep up association work, but extra effort on the part of the officers has kept the interest up to the average standard and it may well be said that our organization has kept abreast of the times in all particulars.

The association has grown at a steady rate until we now have upwards of 800 members. As an association we are now 30 years old and most of our original members have either passed from earthly view or have laid down the working tools of their profession. While there are about a dozen of the charter members living we have but three present at this convention. We must not only grow in numbers but we should urge the younger members to take an active interest in the work of the organization and push onward if we are to achieve the results sought by the founders of this association.

Our president has labored unceasingly during the past year and his efforts have been crowned with success, as the committee reports will show. The committees are to be congratulated upon the work accomplished and it is hoped that the interest taken will be kept up to the standard in the future.

The executive committee has found it necessary to recommend that the amount of annual dues be raised and this matter will be considered in connection with the revising of the constitution and by-laws. The committee to revise the constitution and by-laws has made its report and the proposed changes have been submitted to the members for their approval or rejection at this meeting.

We have lost 10 members by death during the year. Suitable memorials will appear in the proceedings if available.

We are to be congratulated upon the good showing made by the membership committee and there is yet a good field for opportunity in securing new members.

The financial report follows:

Chicago, Oct. 20, 1920.

Financial

Balance on hand at last report,		$1,325.78
Receipts		
Dues and fees,	$1,284.00	
Advertising,	972.58	
Sale of badges,	17.75	
Sale of books,	12.90	
Interest,	39.25	
Total receipts,		$2,326.48
Total on hand and received,		$3,652.26
Disbursements		
Postage,	$ 121.75	
Printing and engraving,	1,068.54	
Stationery and office supplies,	18.32	
Editing,	75.00	
Stenographer,	100.00	
Expenses various committees,	15.00	
Badges,	15.00	
Salaries and office rent,	800.00	
Convention expenses,	67.60	
Telephone and telegraph,	4.10	
Miscellaneous,	57.20	
Total,		$2,342.51
Balance on hand Oct. 22, 1920,		$1,309.75

Of the above amount $500 is invested in Liberty bonds bearing 4¼ per cent interest, and $300 in a first mortgage note at 6 per cent. The balance of $509.75 is on hand in the bank.

Respectfully submitted,

C. A. Lichty,
Sec.-Treas.

Upon motion duly seconded the treasurer's report was referred to the auditing committee consisting of J. S. Robinson, A. M. Swenson and C. R. Knowles.

The president appointed the following committee on resolutions: E. T. Howson, F. C. Baluss and M. Riney.

The committee on relief presented no report which was an indication that all of our members who desired employment held positions.

REPORT OF THE EXECUTIVE COMMITTEE

Chicago, March 17, 1920.

Pursuant to call the executive committee met at the Congress Hotel, Chicago, and was called to order by President Weise. Executive members present, F. E. Weise, J. H. Johnston, J. P. Wood, A. B. McVay, E. T. Howson, C. R. Knowles, Arthur Ridgway and C. A. Lichty. Past presidents in attendance were G. W. Andrews, A. Montzheimer, R. H. Reid, L. D. Hadwen, and C. A. Lichty.

The secretary explained that the unusual delay in getting out the proceedings of the last convention was due to the inability of the printers to provide a suitable quality of paper stock and other materials.

W. A. Spell of Atlanta, member of the committee on arrangements, was present and reported progress which had been made. The committee recommended that inasmuch as the Inter-State fair would be held in Atlanta the same week that our 1920 convention was to be held it would be better to postpone the date one week. After some discussion it was decided that such arrangement would be made and due notice published.

The matter of revising the Constitution and by-laws was discussed and it was recommended that the president appoint a committee to draft the proposed changes and submit their recommendations in time to be acted on at the next annual meeting. The committee appointed consisted of E. T. Howson, A. Montzheimer, C. R. Knowles and the secretary.

Meeting adjourned.

C. A. Lichty, Secretary.

Letters and telegrams were read from a number of members who were unable to be present,—among whom were A. B. McVay, F. E. Schall, W. A. McGonagle, A. E. Killam and G. W. Rear.

President Weise:—We are now ready to take up the subjects for report and discussion. You will notice that the reports have all been bound in one volume, which makes it very convenient. We will take up the report on The Abuse of Treated Timber.

The report was read by assistant secretary Knowles and the discussion opened by A. J. James, the chairman of the committee. (See report and discussion.)

The discussion was closed at the noon hour and adjournment taken until 2 o'clock.

AFTERNOON SESSION

Tuesday, Oct. 26, 1920.

Afternoon session called to order by President Weise at 2 o'clock.

A short time was devoted to moving pictures showing treatment of timber by the open tank or dipping process.

C. R. Knowles read his paper on The Use of Electricity for Pumping Water. (See paper and discussion.)

In the absence of the chairman, Secretary Lichty read the report of the committee on The Repair and Maintenance of Tank Hoops. (See report and discussion.)

The secretary called attention to the fact that a report on Tank Hoops was presented at the Denver convention in 1910, which may be found on page 120 of the twentieth annual proceedings.

The report on Spray Painting was taken up and read by the

secretary. The discussion was deferred until the evening session. (See report and discussion.)

The chairman at this time called on the committee on subjects to make some suggestions.

C. R. Knowles:—It is the duty of the committee on subjects to present to the association an outline of the work for the coming year, and as you know, the success of a convention depends largely on the reports and discussions, which in turn are dependent largely on the subjects which are selected together with their proper arrangement. There are always plenty of subjects from which to make up a list, but it is a pretty difficult job for 3 or 4 members to get together and select just those that are most timely and appropriate and best suited to the conditions of the railroads and the convention in all respects. In reality the main difficulty we have to contend with is not in the selection of subjects, but from a large list to apply the process of elimination until only the right number of the best and most timely remain. We want you all to assist in offering suggestions in order that we may be able to present our report tomorrow.

The President:—We will close earlier than usual this afternoon in order that we may have a little time to devote to the supply men's exhibits. They spend considerable time and money in preparing these exhibits and it is proper that we should look them over and become acquainted with the latest things on the market and their use.

Meeting adjourned at 4:45 p. m.

EVENING SESSION

Tuesday, Oct. 26, 1920.

Call to order at 7:45 p. m. by President Weise.

The Secretary: Professor Branch of the Georgia School of Technology is here accompanied by a number of the students who came to hear the talk on concrete to be given by Col. Boyden. Unfortunately Col. Boyden will not be here until tomorrow but we extend to Prof. Branch and his pupils a cordial invitation to remain for our evening program and to return tomorrow to hear the address on concrete.

The subject of Spray Painting was taken up for discussion, after which Maro Johnson gave a description of the erection features of the new St. Charles Air Line bridge at Chicago, illustrated by moving pictures and lantern slides.

Hunter McDonald read a paper on the Housing and Feeding of Maintenance of Way Employees on the Nashville, Chattanooga & St. Louis railway. This was also illustrated with lantern slides. (See page 179)

J. K. Melton favored the association with a series of motion pictures and lantern slides on bridges and bridge work.

Adjourned at 10:00 p. m.

MORNING SESSION

Wednesday, Oct. 27, 1920.

Convention called to order at 9:20 by President Weise.

The proposed revision of the Constitution and By-Laws was presented at this time.

E. T. Howson:—Your committee on amendments, appointed by the president, consisting of C. R. Knowles, A. Montzheimer and the speaker (assisted by the president and secretary), gave this subject consideration for a period of 6 or 8 months. We had a number of meetings, received suggestions from a considerable number of the members, and every one of those suggestions came before the entire committee, as well as before a number of other members of the association who were close to us in Chicago so we would get the benefit of their advice. As a result the amendments submitted to you embody ideas that probably 25 of the members submitted. The committee felt in beginning its work that we were confronted with the necessity of making certain changes in the constitution to enable the society to adjust itself to an organization of 800 to 1,000 members, whereas the present constitution was revised when the membership numbered only about 300. You will note that the changes are nearly all minor and are simply to facilitate the business of the association.

Mr. Howson pointed out the proposed amendments which were taken up article by article and adopted as a whole. Several important items in the revision appear as follows:

Life members shall be elected on the recommendation of the executive committee, which committee shall report its recommendations to the association annually.

The word "directors" has been substituted for those who were formerly termed executive members.

The most recent past president is retained in the capacity of a director for one year following his term of office because, as president, he has gained much information that should be of

value to the association. His guidance should be sought and for that reason it was deemed wise to make him a voting member of the executive committee.

Three members of the executive committee shall be elected each year, to serve for two-year terms.

Mr. Howson continued by calling attention to the proposed changes in the by-laws, the important items recommended being as follows:

The executive committee has the power to change the dates of the annual meeting as well as the location, if for any reason it becomes absolutely necessary.

The committee recommends raising the annual dues from the old figure of $2 to that of $3 or $4. At a meeting of the executive committee last evening it was voted to recommend raising the dues for the present time to $4.

A free discussion on the matter of the amount of annual dues resulted after which the proposed changes of by-laws were adopted naming the dues at $4.

Before the adoption of the by-laws as amended, W. M. Camp moved that the item of " Reading Minutes of last Annual Meeting " be omitted from the order of business, stating that it was a custom that was obsolete. Motion lost.

President Weise:—The committee is dismissed with many thanks for the hard work it accomplished in bringing about the desired results. We will at this time call on the auditing committee for its report.

J. S. Robinson:—The committee has audited the books and accounts of the secretary-treasurer and found them correct which agrees with the report made at the opening session.

As chairman of the auditing committee I wish to state that I have gone over the bills at the secretary's office a number of times, with other members, and we were surprised at the manner in which the expenses were kept down. We were impressed by the fact that the bills have not advanced in proportion to the growth of the association. Keeping down the expenses and the dues so long has required a great deal of hard work on the part of the secretary and I think the association ought to give him a vote of thanks for it.

I will offer as a motion that we extend to our secretary-treasurer a rising vote of thanks for his untiring efforts in behalf of our association and the good work he has done.

A unanimous rising vote of thanks was extended.

A recess of 15 minutes was taken, after which President Weise introduced Lt. Col. H. C. Boyden, of the Portland Cement Association, who came from Chicago to address the convention on the subject of "Recent Developments in Concrete."

Mr. Boyden:—Mr. Chairman and Gentlemen,—I always feel right at home when I am talking to railroad men because I was myself a railroad man for 14 years, and I am thoroughly familiar with the work that you gentlemen do on the railroads in all parts of the country, and I believe that the things that I am going to tell you today will be of value and of interest to you. I know there are many here who are more or less familiar with some of the things, but I feel also that there are many here who are not familiar with them, and you will find them quite revolutionary, and will probably change a good many of your previous ideas on the making of concrete.

About six years ago the officials of the Portland Cement Association, which is an association supported by practically all of the cement manufacturers in the country—not a selling organization, but an organization maintained for the promotion of the use of concrete where adaptable, for the investigation of the making of concrete in all of its phases and for the spreading of that knowledge among the makers and the engineers of the country for the betterment of the art of making concrete, realized that there was very little known about the real structure of a concrete mixture. After careful search they found a man who seemed preëminently qualified for making an investigation of the structure of concrete, and placed him in charge of a large laboratory which is operated jointly by the Portland Cement Association and the Lewis Institute in Chicago, and it is the results of this investigation which has been going on since 1914 that I want to tell you about today.

There are only two ideas governing the policy of this laboratory. The first is that all the facts, the real facts, regarding concrete shall be found out. The second is that no matter what those conclusions may be, they shall be given out to the engineers of the country for the betterment of the art of making concrete. These investigations are still being carried on, but many points of vital importance have already been established. As an example, the data already established warrant the use of a considerably higher unit stress in concrete than that in common use

today, with a consequent possible reduction in section. Conclusions have also been reached that will enable us to use aggregates heretofore condemned, and also to greatly increase the ability of concrete to withstand abrasion. These conclusions and many others are all based on tests running into the thousands and covering long periods of time. Incidentally, I might mention that the laboratory is equipped for, and is today making close to 50,000 tests a year, so there is no lack of facilities for carrying our investigation to a logical conclusion.

(Lt. Col. Boyden reads paper and explains lantern slides.)

President Weise:—Col. Boyden, the Association thanks you most heartily for coming here and addressing us on this most important subject this morning. I know from the attitude of every one present that they appreciate this, because they realize that it is a very valuable paper.

This will be printed with our regular reports and appear in the proceedings. (See Paper.)

REPORT OF NOMINATING COMMITTEE

Atlanta, Oct. 27, 1920.

The nominating committee has rearranged its recommendations to conform to the requirements of the revised constitution and by-laws and submits the following names for officers and directors for the ensuing year:

For President, W. F. Strouse, Baltimore.
First Vice-President, C. R. Knowles, Chicago.
Second Vice-President, A. Ridgeway, Denver.
Third Vice-President, J. S. Robinson, Chicago.
Fourth Vice-President, J. P. Wood, Saginaw, Mich.
Sec.-Treas., C. A. Lichty, Chicago.
Directors (term expiring 1921), C. W. Wright, A. B. McVay, and G. A. Manthey.
Directors (term expiring 1922), E. T. Howson, J. H. Johnston, and E. K. Barrett.

It is not necessary to nominate Mr. Weise as a member of the board of directors as the new constitution provides for this.

Respectfully submitted,

A. Montzheimer, Chairman.

President Weise:—You have heard the report. The election will take place tomorrow.

The secretary next presented the report of the obituary committee.

Atlanta, Ga., Oct. 27, 1920.

Whereas: It hath pleased our Heavenly Father to remove from our midst during the past year our beloved members, J. H. Cummin. B. F. Pickering, Aaron S. Markley, C. F. Flint, J. S. Berry, W. H. Moore, Cyrus P. Austin, Geo. McMahon, Alf. Brown and P. E. Parsons;

Therefore, be it resolved, That the members present at this conven-

tion express their sincere sorrow by standing in meditation and prayer for two minutes, and,

Be it further resolved, That these resolutions be printed in our proceedings and a copy forwarded to their respective families.

Geo. W. Andrews, Chairman.

President Weise:—Let us adopt the recommendation of the committee by standing in silent meditation until the sound of the gavel.

(Members all rise and bow heads until tap of gavel.)

I am very glad that the association has given recognition to these departed brothers because so many of them, in fact a greater number than in any previous year, were prominent in our early history and had much to do with the organization and the work connected with it. Three of them, as I stated yesterday, were past presidents.

We will next take up the subject of Maintenance of Timber Docks for report and discussion. (See report and discussion.)

The next report considered was that of "Filling Bridges."

Secretary Lichty reads excerpts from the report. (See report and discussion.)

The report on Reclamation of Bridge, Building and Water Supply Materials was passed without reading, to be published in the proceedings as information.

After outlining the program for Thursday morning the president adjourned the meeting at 12:30 until 8:30 a. m.

The afternoon (Wednesday) was occupied on the trip by special train to the shops of the Nashville, Chattanooga & St. Louis Ry., and the bridge on that road over the Chattahoochee river.

MORNING SESSION

Thursday, Oct. 28, 1920.

Meeting called to order by President Weise at 9 o'clock.

Arthur Ridgway was called upon to present the committee report on Standard Forms for Bridge Inspection. (See report and discussion.)

Following this was taken up the report and discussion on the Repair and Maintenance of Freight House Floors, which was introduced by C. P. Rawson. (See report and discussion.)

The president called on F. C. Baluss to give the report of the committee on resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS

Atlanta, Oct. 28, 1920.

Resolved:—That the thanks of the Association be extended to the following individuals and corporations:

To the Hon. James L. Key, mayor of Atlanta, for his address of welcome extending the courtesies of the city of Atlanta to this Association.

To Mr. Eugene Black, president Atlanta Chamber of Commerce, for his welcome from the Civics bodies of Atlanta.

To the Nashville, Chattanooga and St. Louis Railway Company, for its special train to the Hills Parks Shops, and the Chattahoochee River bridge and to Mr. Hunter McDonald, chief engineer, for courtesies extended.

To the Pullman Company, the Big Four Railway Company and the Southern Railway Company, for special trains and rates to and from the convention.

To Lt.-Col. Boyden of the Portland Cement Association for his splendid lecture on concrete.

To the management of the Piedmont hotel for courtesies extended.

To the Bridge & Building Supply Men's Association for the exhibits and entertainment provided.

To the Capital City Club for the use of its beautiful club building for the evening of the annual dinner.

To the City Press and the Technical Journals for publishing reports of our meetings.

To the officers of the Association for their untiring efforts for the success of the convention.

To the Georgia Railroad for the special train to Stone Mountain.

To the railroads of Georgia and Florida for special arrangements in providing accommodations for our members and their families who took side trips to various points in Florida after the convention.

To the chairmen and members of the committees for their splendid reports, and especially to the committee on arrangements, who with the other Atlanta members contributed so freely to make every moment of our stay in Atlanta pleasant.

Be it further resolved, That these resolutions be spread on the minutes and the secretary be instructed to forward copies to all interested parties.

Respectfully submitted,

F. C. Baluss,
E. T. Howson,
M. Riney,
Committee.

C. R. Knowles was called upon to present the list of subjects selected for the coming year.

REPORT OF COMMITTEE ON SUBJECTS

1. Tools and Equipment for Pile Driver Outfits.
2. Recruiting of Bridge and Building Employees.
3. The Effect of the Eight-Hour Day.
4. The Detection and Repair of Leaks in Water Mains.
5. The Cleaning of Structural Steel Before Painting.
6. The Construction and Maintenance of Cinder Pits.
7. The Lining of Tunnels Under Traffic.
8. The Construction and Maintenance of Passenger Platforms.

It is the aim of the committee to amplify the subjects by giving an outline or synopsis of the scope to be covered by each committee report. It is also within the province of the committee to select one or more special subjects for papers to be presented at the next meeting.

We trust our members will take an active interest in gathering information for these reports whether their names appear on the committees or not.

Respectfully submitted,

C. R. Knowles,
E. T. Howson,
A. T. Hawk,
J. P. Wood,
Committee.

Upon motion duly seconded the report of the committee on subjects was adopted.

President Weise:—I know the committee has given the matter of the selection of subjects careful thought, not only since we have met here but prior to our arrival, and while a large number of subjects have been presented it was thought that the eight which have been selected were probably the ones of widest interest to the members.

The next order of business is the selection of the next meeting place. This is an important item in connection with our work of the morning, but I am going to ask that you make your talks as short as possible. There is one thing you will all concede; we must remember that our association has grown to such proportions that we have to take many things into consideration. We should select places where we are assured of a good attendance. We want to shift about to different places of the country for various reasons. We are also obliged to select places that can take care of us and that is not so easy as it was years ago. Besides we must be assured of good convention halls.

M. Loeffler nominated New York City, stating that we have never held a meeting there.

A. J. James nominated Kansas City, mentioning the good points in connection with that location.

R. H. Reid nominated Chicago and C. P. Rawson suggested that we consider Boston.

G. W. Andrews:—I was thinking of suggesting Baltimore as our next meeting place, but after a canvass of the place we find it is doubtful if we could get satisfactory hotel accommodations. The city, as you know, does not have very many good hotels. I would like to see the next convention located somewhere in the east, not for any personal reason, but our president-elect is from Baltimore and I would like to see the next convention go somewhere in the east as a compliment to him, and while I personally would not vote for New York for any other reason I will however vote for New York in this instance.

J. S. Robinson concurred in the choice of New York City, setting forth many good reasons.

The first vote resulted overwhelmingly in favor of New York City as the next meeting place.

The president announced that the next order of business would be the election of officers.

The secretary read the report of the nominating committee.

G. W. Andrews moved that F. C. Baluss cast the vote of the association which would elect all of the nominees as recommended by the nominating committee as shown in their report.

The motion prevailed and Mr. Baluss cast the ballot, whereupon it was declared that the nominees were duly elected.

The retiring president, F. E. Weise, called upon Geo. W. Andrews as the oldest surviving past president to install the new officers.

Past presidents, J. S. Lemond and S. C. Tanner were called upon to conduct President-elect Strouse to the chair. The four vice-presidents and the secretary-treasurer were asked to come forward, as well as the newly elected directors.

G. W. Andrews:—Mr. Strouse and officers-elect, it affords me a great deal of pleasure to assist in installing you as officers of this association. We want to bear in mind that this association is composed of some of the best material that is turned out by the combined railroads of the United States and Canada, and many other countries. We were small in numbers at first but I felt it was an honor to be elected a member in 1894 (when the association was three years old) at which time we had 122 members but I think it is a greater honor to be elected to these positions by the present organization which is composed of about 850 members. Your duties will not be more severe than were the duties of the officers in the early days, because then they had a great deal of constructive work to do in building up the organization and to get it in smooth working order. It required an enormous amount of work for the faithful officers and members in the past to build up this society to the present high standard, and I say high standard without qualification—because our papers and discussions occupy a high rank and are not only read by men occupying high positions on the railroads but our books are found in many of the city and college libraries where they are, in some cases at least, used as text books. It therefore behooves us to continue the good work and improve from year

to year in accordance with the standard set by our early officers.

Mr. Strouse, it affords me more than a little pleasure, having been intimately associated with you for so many years in railroad life, to install you in the office of president of this Association, and you are herewith presented with the gavel as an emblem of authority of the position.

The remainder of the officers were declared installed in their new positions.

President-Elect Strouse:—Mr. Andrews, Mr. Weise, and fellow members of the American Railway Bridge & Building Association:—In accepting this symbol of office I wish to express my appreciation of the honor conferred upon me in electing me president of this association. At the same time I want to assure you that I fully appreciate the responsibility you have placed upon me. In order that the work of this association may be kept up to the standard of past years, I will need your coöperation. The bulk of the work, of course, will have to be performed by committees, and it is my sincere hope that I will have the same support that has been accorded my predecessors in this office.

Since leaving the railroad service two years ago, my time and what talents I possess have been directed along other lines of endeavor, in many respects of a broader nature, but I shall never cease to be interested in railroad activities, to which over 30 years of my life have been devoted. It is my purpose to give the association my best efforts during the coming year, and, with your coöperation, I hope to maintain the standard set many years ago.

I thank you. (Applause.)

Retiring President Weise:—Mr. Strouse, may I say just a word? I don't want to let this occasion go by without publicly expressing my thanks and appreciation to the other officers that were my collaborators, and to the committee members and to those members of the association that responded so promptly to all the requests that were made. I appreciate that, personally, very much. While this has been a busy year, it has been a very happy one, and I have made many warm, personal friends. I want to thank you all in this way for helping me out as you did. (Applause.)

Final adjournment was taken at 11:30 Thursday morning.

C. A. Lichty, Secretary.

(Reported by LeRoy W. Hoskins on the Stenotype.)

WILLIAM HARLEY MOORE

(By Clarence Blakeslee)

Died September 5th, 1920

William Harley Moore was born on September 12th, 1860, in Limerick, Ireland. He was the son of William Harley Moore and Mary Elizabeth Ledger Moore, and the grandson of the late Zackariah M. Ledger, all of Limerick, Ireland. His uncle, James C. Ledger, was a prominent engineer of irrigation and bridges in India, and built the Great Bridge over the Narbudda River. Mr. Moore studied at Queen's College, Cork, where he was awarded a number of first prizes in Mathe-

William Harley Moore

matics and a prize in Philosophy. In three years he had won his B. A. degree with first scholarship in Engineering, and in the next two years was awarded the degree of Bachelor of Engineering. He took his degree of Master of Engineering at the Royal University of Dublin, and won first class Exhibition and first class Honors. Queen's College later conferred on him the honorary degree of Master of Arts.

On completing his University work, Mr. Moore came to America, and in 1885 and 1886 was employed as a Draftsman in the Bridge Engineering Department of the New York Central and Hudson River Railroad. In May, 1886, he entered the employ of the New York, New Haven and Hartford Railroad, with which Company he continued until his death. He was appointed Bridge Engineer of the New Haven Railroad in January, 1889, and Engineer of Structures in May, 1913.

Nearly all the four-track bridges between New York City and New Haven, Conn., were designed and built under his supervision. Many six-track bridges on the Harlem River Branch, between New York City and New Rochelle, N. Y., including several large draw-bridges, were also built by Mr. Moore. He also either rebuilt or strengthened many very large bridges of the New York, New Haven and Hartford System, among which were the large bridges over the Connecticut River, at Warehouse Point, Middletown, and Lyme, Conn., and the bridge over the Cape Cod Canal at Buzzard's Bay, Mass. The Thames

River Bridge, at New London, Conn., was the last bridge designed and built under his supervision, and will remain as a monument to his ability.

Mr. Moore was a member of the American Railway Engineering Association, which he joined in 1900, and served on many of its important committees on iron and steel structures. He was made Chairman of the Sub-Committee on Column Tests, Committee XV, in June, 1912, and served in that capacity until the time of his death. He was also a member of the American Society for Testing Materials and the American Railway Bridge and Building Association.

Mr. Moore was not married. He leaves as his nearest relatives, his mother, Mrs. Mary Elizabeth Moore, and a sister, Mrs. George B. Chamberlin, both of whom reside in Brookline, Mass., and several nephews and nieces. He died suddenly on September 5th, 1920, at his residence in New Haven, Conn., of heart failure, resulting from bronchial trouble to which he had been subject for many years.

Mr. Moore's great technical ability was recognized by all who knew him professionally, and his loss will be severely felt in his various fields of professional activity. His artistic tastes led him into a wide study of music and literature from which he gained keen pleasure. His taste for the æsthetic made him a most valuable and congenial companion at all gatherings where music or the drama contributed to the entertainment.

He was a good friend, a man among men, actuated by the highest ideals, and sympathetic in all his associations with his fellows. He was a genial and dignified gentleman, filling a large place in engineering circles, where his loss has caused deep sorrow.

Mr. Moore was elected a member of the American Railway Bridge and Building Association in 1906.

JOSEPH H. CUMMIN

Joseph H. Cummin was born at Buffalo, N. Y. on March 11, 1849, and died at his home at Brightwaters, Long Island, N. Y., Feb. 29, 1920, following a slight attack of indigestion which induced heart failure. He was educated in the public schools of New York City and entered the law office of Rice and Hill at 44 Wall St. on June 20, 1859, where he remained until September, 1861, when he enlisted as a drummer boy in Co. K, 44th N. Y. Infantry and re-enlisted December, 1863, as a private in Co. A, 16th N. Y. H. A. He was honorably discharged Aug. 28, 1865. He was in a large number of general engagements but never wounded.

His parents having moved from New York City to Elmira, he went there after being discharged from the army, and worked at the carpenters' trade, his father being a builder. He went from Elmira late in 1867, to Babylon, Long Island, where he worked at his trade until 1878 when he entered the service of the Manhattan Beach R. R., remaining until 1881 when he became superintendent of bridges and buildings of the Long Island Railroad. He held this position until July 1, 1907, when he resigned and accepted the position of general superintendent of the T. B. Ackerson Co., in developing a large tract of real estate at Brightwaters, Long Island, which was one of the most famous developments in the vicinity of New York City. When this work was completed he returned to the Long Island railroad and was made inspector of heating plants, which position he held at the time of his death.

Mr. Cummin was married to Louise Duryea on March 29, 1868; they celebrated their golden wedding on March 29, 1918. Besides his wife Mr. Cummin is survived by two sons, John D., of Newark, N. J., and Jos. W., of Brooklyn; two daughters, Mrs. Geo. M. Owen, of Brooklyn and Miss Clara Cummin, of Brightwaters; five grandchildren and two great-grandchildren.

In fraternal circles Mr. Cummin belonged to the Odd Fellows, Royal Arcanum, Grand Army of the Republic and the Masonic Order. In the Masonic Order he was the oldest past master of his lodge, past commander of his Commandery, and the oldest past potentate of Kismet Temple of the Mystic Shrine. He was also a 33rd degree Mason. He

Joseph H. Cummin

was always interested in fire department matters and arranged the first firemen's tournament ever held on Long Island, and was presiding judge ever after at all contests. Several years ago the Suffolk County Association presented him with a gold badge inscribed, "30 Years a Just Judge." He was connected with the Baptist church since 1871 and was superintendent of the Sunday-school and chorister for eleven years.

Mr. Cummin joined this Association the year following its organization and was one of its staunch supporters and a loyal and earnest worker. He was president the year the convention was held in Detroit in 1899. He attended many conventions and was always called upon for the opening prayer when he was present.

He was buried with full Masonic rites, and his body rests in the beautiful rural cemetery at Babylon, Long Island, New York.

B. F. PICKERING

B. F. Pickering was born in Wakefield, N. H., October 5, 1857, and died suddenly at his home in Salem, Mass., August 30, 1920, from heart failure. He had been in poor health for a year or more but was able to attend to his railroad duties until the time of his death. He had just returned from a short vacation and was not feeling unusual when early in the morning of the day when he expected to resume his work he passed from this life suddenly, in the presence of his wife and daughter.

Mr. Pickering was educated in the schools of Wakefield, Somersworth, N. H., and Eliot, Maine. He made his own way in life from the time he was 10 years of age. In 1883 he entered the employ of the Eastern R. R., as passenger brakeman. In October, 1885, he left the

service to accept a position with the Government at Portsmouth navy yard, and in November, 1890, entered the service of the Boston & Maine as carpenter, at Sanbornville, N. H. In October, 1893, he became supervisor of bridges and buildings on the northern division, and upon the breaking up of the division in 1903 he was made general foreman in charge of the Conway Branch, which position he held until August, 1910, when he was promoted to supervisor of bridges and buildings for

B. F. Pickering

the entire Portland division. This was a consolidation of the eastern and western divisions, having headquarters at Salem, Mass., and this was the position he held at the time of his death.

Mr. Pickering was a devoted Christian and often remarked that he was prepared to go at the Master's call. He is survived by his wife, one son and one daughter. He was buried in the family lot at Sanbornville, N. H.

Mr. Pickering was of a genial disposition and was popular alike among his employers and employees. He was a devoted and enthusiastic worker in the Association, having joined at the convention which was held in Richmond in 1898. He was president at the meeting held in Quebec in 1903 which will be remembered as one of the banner conventions in the history of the Bridge and Building Association.

AARON S. MARKLEY

Aaron S. Markley was born on a farm adjoining the Borough of North Wales, Montgomery Co, Pa, Nov. 25, 1850. In the spring of 1863 he went west with an uncle and lived with him on a farm two miles west of Crawfordsville, Ind., until November, 1866, when he returned to the old home at North Wales and took up work as a carpenter where he worked four years, when he went back to Crawfordsville. At this time (about 1870) he took up railroad work when he helped build the bridges on the Indianapolis, Bloomington & Western between Indianapolis and Urbana. He succeeded to the position of bridge foreman about 1874, in which capacity he remained, with the same road, until 1882, then going with the Chicago & Eastern Illinois as master carpenter, having charge of all the bridges and buildings, in which capacity he remained until his death, which occurred October 13, 1920.

Mr. Markley was in his usual good health until a few days before he died. He had completed all arrangements to attend the thirtieth annual convention at Atlanta with Mrs. Markley, who always accompanied him on the convention trips, after which they intended visiting points in Florida. He was a charter member of this Association and

Aaron S. Markley

always took an active interest in its affairs and served as its president from Oct. 1906 to Oct. 1907. He was especially active in all of the discussions which came before the society and was always particular in seeing that the business was handled and disposed of in proper order.

Mr. Markley was married in March, 1876, to Miss Ella Warfel, of Claremont, Ind Two daughters and one son, together with Mrs. Markley survive. John H. Markley, a brother, resides at Peoria, Ill.

Mr. Markley was a 32nd degree Mason. He was, at the time of his death, serving his second term as alderman of his ward in the City of Danville, and was chairman of the bridge committee. He was an active member of the First Methodist Church of Danville.

CHARLES F. FLINT

Charles F. Flint died suddenly, Nov. 17, 1919, as a result of heart failure, within a month after having returned from the convention at Cleveland. He appeared to be in his usual health when he was stricken while waiting in the depot at Essex Jct., Vt., to take a train for his home at St. Albans, after spending the day with one of the bridge crews

Mr. Flint was 63 years of age and had been in the employ of the Central Vermont for 30 years, 25 of which he held the position of supervisor of bridges and buildings.

Mr. Flint was a prominent citizen of St. Albans, being a member of the Rebecca Lodge and a past chief Patriarch of the Independent Order of Odd Fellows.

The funeral was held from the Congregational church of which the deceased was a member. He joined the association at Detroit convention in 1899 and attended many of the annudl conventions.

CYRUS P. AUSTIN

Cyrus P. Austin was born May 17, 1838, in the town of Mercer, Maine, and died January 4, 1920, at his home in Medford, Mass., at the age of 81 years and 7 months, from cerebral hemorrhage.

During his early years the family moved to Lowell, Mass., where he served his apprenticeship with his father as a carpenter.

Cyrus P. Austin

His first railroad experience was with the Fitchburg Railroad, where he remained nearly two years, and then entered the service of the Boston & Maine, where he was employed in the bridge and building department 49 years and 6 months, when he was retired on a pension in March, 1911.

Mr. Austin was not fortunate enough to receive a good early education and for that reason he attended night schools, studying everything that he could get in his line of work.

He took an active interest in the affairs of the American Railway Bridge and Building Association and attended the meetings quite regularly when he was able to leave his work. He joined the Association in 1894, at the Kansas City convention.

Mr. Austin was a prominent member of various Masonic orders.

DOUGLAS FIR LOG SECTION

The above cut was reproduced from a drawing made for the West Coast Lumbermen's Association for the technical purpose of showing as many grades of lumber as possible under the West Coast grading rules and to indicate those portions of the log from which these grades are cut. In commercial practice the logs are not cut to as many grades as shown in the accompanying illustration, but the cutting shown is entirely practical.

The particular log shown in the illustration reached a diameter of 24 inches at an age of 65 years, 36 inches at 140 years, and 48 inches at the time it was cut, which was at the age of 275 years. It reached a growth of 6 rings to the inch at an age of 36 years, during which time the average growth was at the rate of 4 rings to the inch. The rate of growth at the time of cutting averaged from 20 to 25 rings per inch.

Douglas fir grows in dense stands and of large size, commonly running over 100,000 board feet to the acre, with individual trees up to 14 and 15 feet in diameter and over 300 feet in height which sometimes grow to a height of 150 feet without a single branch. Its large size accounts for the fact that over 90 per cent of all Douglas fir cross-ties manufactured are sawed from the logs, and the cut shows why most of these must of necessity be sawed from the heartwood.

It has been estimated from reliable data that probably one-quarter of the total timber stand in the United States today is represented by the Douglas fir stands in the Pacific Northwest and we therefore believe this cut of the Douglas Fir log section will prove to be of important interest to our members.

THE ABUSE OF TREATED MATERIAL

REPORT OF COMMITTEE

The purpose of treating timber is to prevent decay and extend the life of the timber. This result is usually accomplished by impregnating the timber with a preservative of some kind, creosote oil being generally used for bridge timbers and timber used in similar structures.

The efficiency of the treatment is dependent upon and is usually measured by the depth of penetration and the extent to which the untreated portion of the timber is sealed against decay by the treatment. It is obvious that anything done to the treated timber which tends to lessen the thickness of the treated area is abuse and destroys the effect of the treatment to the extent that the treated area is reduced. If the timber is cut or sawed until the untreated timber is exposed, decay will be practically as rapid and will do as much damage as if the timber was used without treatment. While it is a recognized fact that it is often necessary to cut or frame treated timber after treatment, much of the framing can and should be done before the timber is treated and whenever it is actually necessary to frame treated timber care should be exercised to see that the work is done in an intelligent manner and with as little damage to the treatment as possible and that hot creosote oil is applied to the cut portion of the timber.

A few examples of the proper treatment of treated material follow:

1. When treated piles are cut off after driving, the tops of piles should be thoroughly coated with hot creosote oil. It is not enough to paint the tops but oil should be applied as long as the timber will take it.
2. When boring holes in treated material, holes should be made slightly smaller than the bolts so that a driving fit will be obtained. It is still better to pour hot creosote oil in the holes before driving the bolts.
3. Where piling is not in proper line after driving, a treated pile should never be adzed to make the bracing fit up, but if the piles are greatly out of line blocks should be applied to the piling to bring the bracing in line. In extreme cases it may be necessary to place lap bracing instead of bracing extending clear across the bent.
4. The end penetration on a well-treated timber is usually from 3 to 6 inches in depth. Therefore, an inch or so sawed from the end of a well-treated timber will not materially affect the life, but any framing of treated timber that penetrates the area of treatment certainly tends to destroy the effect of the treatment.

The following instructions should be observed in handling creosoted timber:

1. In unloading creosoted timber care should be taken to see that it does not drop from too great a height to the ground as it has been found in a great many instances that heavy timbers are broken or cracked which is no doubt due to the manner in which it was unloaded. Treated timber is more susceptible to damage from this cause than untreated timber on account of the lessened strength of the timber through treatment.
2. Creosoted material should not be mistreated with bars, picks, cant or lug hooks in such a way as to make holes extending through the treatment.
3. In cutting off the piles the tops should be thoroughly covered with hot creosote oil. Better penetration can be obtained by boring

holes in the heart of the piling and filling with hot creosote oil. All exposed cut surfaces should be thoroughly covered with hot oil.

4. In placing sway bracing on bents it is often the practice to cut away piles so that the brace will give more satisfactory bearing. The treated piles should not be cut away to make the bracing fit up, if possible to avoid it, but if piles are greatly out of line blocks should be applied to bring the bracing in line. Where necessary to cut the piling the exposed surfaces should be covered with hot creosote.

5. Frequently holes are bored in treated timber and left unfilled. These holes should always be plugged with plugs of treated timber.

6. In general all portions of treated timber which have been cut or bored below the penetration of the creosote should be covered thoroughly with hot creosote oil.

There is no longer any guess work regarding the results which can be obtained through the use of treated timber. Railroad piling, bridge lumber and ties not only have to resist decay but the treatment must be so thorough that it will continue to be effective under severe mechanical wear. Standard practices have been developed that can be relied upon so that, with proper supervision, results of a definite quality may be obtained. In the following report the committee has endeav-

Figure 1. Treated Tie in Service 26 Years

ored to show clearly the differences between thoroughly treated material, and material not well treated, the causes for defective treatment and also to show how properly treated material is abused, and the value of this treatment thus entirely thrown away.

The preservation of wood cannot be accomplished in a casual, offhand manner. Permanence in service requires the proper penetration of the preservative in the timber treated, and this can be obtained only by the use of proper timber, proper methods, proper preservatives, proper equipment and careful supervision, through all stages of the operation of treatment. It is conceded by all who understand the subject that if one starts with a sound piece of wood, either lumber, piling or cross ties, he can give it a treatment that will protect it from decay beyond its mechanical life; but by no means is every piece of material treated in this manner. The committee will endeavor to point out some of the causes of failure.

Lumber is composed of two kinds of wood—sap and heart. The sapwood has all the elements of decay within itself and all it needs is the atmospheric conditions to bring the germs of decay to active life. The heartwood is healthy; it has been protected by nature in a manner such that if all outside influences are kept away, it will stay sound for an indefinite period; so in treating a stick, if one absolutely assures

that every inch of sapwood is penetrated and the heartwood is surrounded by a treated layer of wood that will not be broken, the problem of preservation has been solved.

Entirely too often the acceptance or rejection of treated timber is based entirely upon penetration, regardless of whether the timber is

Figure 2. Drain Boxes, Showing Decay of Material Where Treated Lumber Is Cut

heartwood or sapwood. When this is done, the purchaser is as apt to accept timber where sapwood only has been treated as he is to reject heartwood with ample treatment to make it last indefinitely. In this connection, the committee would like to emphasize the fact that if the sapwood is thoroughly impregnated the heartwood will last if the treated area is sufficient to compel every bit of moisture that enters the timber to pass through a treated layer of wood and thus be sterilized

To illustrate this point clearly, we show in Fig. 1, one of a lot of 600 ties that were in the track from 1882 to 1908—26 years—and was only removed from the track for purposes of inspection, the remaining 600 still being in service at the time this was taken out. This tie is what is called a half moon tie, with sapwood all around except where it was cut from the heartwood—viz., at the bottom—and while every bit of the sapwood is well treated, you will note that the bottom of the tie—the heartwood has not a quarter of an inch penetration and yet it is in a perfect state of preservation after 26 years' service.

Figs. 2 and 3 are photographs of drain boxes. Fig. 2 illustrates the importance of the use of creosoted material. This is the top of a creosoted drain box which had been in the ground 10 years and is typical of what we may expect if creosoted material is sawed and put into the ground after treatment. Every block in the top of this box that is decayed is a sawed block, while every block that was not sawed is in absolutely perfect condition.

The end penetration of the wood, as the picture demonstrates, is perfect, and if the seal had not been broken it would have been good

Figure 3. Failure of Timber Box Where Treated Timber was Sawed

for an indefinite life. The only reason it was not good is because it was abused by sawing the ends off and exposing the untreated wood to decay.

Fig. 3 is an example of a drain box which was reported as a failure of creosoted material in 1914. The chief engineer received a request from the division engineer for authority to put in a new drain box at this particular location, although the records showed that the old box had been in only 11 years. On investigation, we found that the box was of untreated white oak and had given quite an unusual life in that

Figure 4 Figure 5

Figure 4. Sawed Treated Timber Supporting Sign Board
Figure 5. Treated Piling Before Cutting

condition. Three years before this time they had extended a side track along past this box, and put in what was supposed to be a creosoted box under the siding. On examination of the end of this box, the creosoted planks were found to be in good condition, but on closer investigation fungus was found to be hanging from the center of the box about 8 ft. from the end. A section gang was secured to excavate around the box to find out what was the matter and the picture shows clearly the condition of the box as it was found. What had been done was this: Every creosoted piece that went into that box had been sawed after it was treated. There were not quite enough boards to complete the top so they went out and picked up a 2-in. plank and filled in the space where you see the fungus was hanging. One was not thick enough so a second one was put on. These two untreated pieces were in the condition represented in three years' time; and not only

Figure 6. Condition of Fig. 5 Upon Being Cut

that, but they had infected the sawn ends of the creosoted plank.

This, we think, demonstrates clearly that if we are going to let our material be mutilated in this manner, it gives people who do not know the creosoting game a feeling that there is something decidedly wrong and that the whole treating business is worthless. It seems that it would be imperative for everyone interested to follow up this kind of work and stop it.

Fig. 4 shows an ordinary railway sign board which is familiar to all. The engineering department had given this simple structure enough thought to draw up plans for it so as to get the maximum life and it is built with a treated base to go in the ground so it will not decay and a section above the ground that can be painted and be permanent; but instead of carrying out the plans the man who executed this, cut a piece of treated material and turned the untreated heart of the stick up to all the heat and moisture, not only defeating the ends of the plan but costing the company money by putting in what amounted to an untreated stick which will come out long before its time, in addition to wasting the cost of treatment.

These are not exceptional examples and none of them are the result of any malicious intent but they are due to the lack of thought and proper reasoning on the part of the men who built them and they are being repeated all over this country day after day, due to lack of education; they have been mentioned that we may see the absurdity of mutilating material after it has once been treated, and to set forth clearly the reason for so many reported failures of treated material. This committee can say with all confidence that lumber properly seasoned and well treated with creosote and used so that the treated seal is not broken will not decay, but treated material used in the manner illustrated by these pictures is just as subject to decay as if it was untreated.

As an example of the care and close inspection that is necessary before material is treated, the committee will point out some of the first defects in timber previous to treatment which cannot be detected by the usual inspection and yet will give poor results unless they are detected.

Figs. 5 and 6 are photographs of the same stick of piling before being cut. Fig. 5 shows the outside of the butt which would indicate that the piling was in first class condition and yet, on taking a 3-in. cut, Fig. 6 shows the condition of the piling on the inside.

Figure 7. Poor Location for Material Yard

In conclusion, the committee would like to lay emphasis on the absolute necessity, (1) that all treated material should be thoroughly air seasoned before treatment; (2) that material to be seasoned for treatment should be piled under proper conditions so that it will have a chance to properly air-season; and (3) that the yard in which the material is to be piled should be thoroughly drained, kept free from weeds and enough space provided between the piles to allow the air to circulate thoroughly, and the timber not to be piled in a yard as shown in Fig. 7, where the conditions are such that it is almost impossible to get material properly to season on account of water standing around and weeds growing everywhere among the material, (4) that it is just as necessary that extreme care be taken in the handling of material after treatment as it is before treatment. This insures that the value of the treatment will not be destroyed. In loading and un-

loading treated material the utmost care should be used in seeing that the seal of the treated area of the wood is not broken, eliminating all rough handling so far as is practicable.

A. J. James (Chairman),
S. L. McClanahan,
J. S. Huntoon,
F. A. Taylor,
F. L. Thompson,
H. von Schrenk,
Committee.

DISCUSSION

(Abuse of Treated Timber)

President Weise:—I will ask Mr. James, the chairman of the committee, if he has anything he wishes to say in opening the discussion.

A. J. James:—I have been using creosoted material a number of years, and I am an ardent advocate of it, as I presume many of you are.

Hunter McDonald:—I am in hearty accord with everything that has been said in this report. There is just one feature that I think the membership will be interested in that I might contribute to the discussion and that is that in sawing off treated piling it is often necessary to saw them off at a point beyond the reach of the end penetration. In driving piling the fiber is disturbed by the hammer in such a way that water, if permitted to enter the pile, will rot it out, even though you soak it with creosote oil. We have for some years been very successfully protecting against this by taking a 5-in. strip of galvanized iron, turning up one edge of it ¼-in. and driving that into the cap and nailing it at a point about 2 in. above the bottom of the cap and parallel therewith, letting the remainder of the iron hang down below the top of the pile. In this way a flashing is placed over the end of the pile, and the entrance of water by capillary attraction prevented. You will see an example of this treatment in the trestle approaches of the Chattahoochee River bridge tomorrow afternoon.

G. W. Andrews:—This report of the committee, while not long, is, in my opinion, a very comprehensive one, and I wish to call attention to some methods that the division people should use in ordering creosoted material. We are so very much in the habit of waiting until we need material before we order it and I can recall in my own personal experience a number of instances

where requisitions have come in for creosoted material and in the column headed "When Required," marked "At Once." Now that is a physical impossibility unless we happen to have that material in stock, or some other supply man or lumbermen or treating companies have it on hand, which is a very rare occurrence. Now we ought to anticipate our needs. We know very well when we are going to rebuild a trestle and we certainly could in the fall anticipate the spring and summer requirements for that material, and the requisition should be made in the fall. The material could then be purchased and stored at the treating plants of those railroads who have it and if not, at treating plants of the individual companies, and be thoroughly seasoned for treatment in the spring, and delivered on the ground in ample time for us to use it.

Now take one little item here which is very interesting to me, that of drain boxes. The Baltimore and Ohio is using a large number of drain boxes of 12-in. inside measurement (nothing above that), and in ordering our materials we get the box the full length, 12, 14 or 16 ft. as may be required, and the tops and bottoms (the cross plank) are cut into 16-in. lengths before treatment. The boxes are made at the treating plants and are sent out on the road ready for installation. When the work is done in that manner there is no reason in the world for a section man or for a carpenter to change anything on that box. The exact length of the boxes should be ordered so that every part of the timber in each box that is exposed is treated. By doing that we have found the life of the boxes to extend beyond our expectations. The same is true in regard to caps on trestles. They should always be ordered in the lengths required. We cannot do that with sills because their length is governed by the height of the bent. The same is true of posts, but we can cover those with the hot creosote when the bents are being built. We obtain the stringers in various lengths, but, try as we will, they will not always meet, and we must cut them to fit, leaving an end that is not treated, and unless we cover that end with hot creosote the resultant effects are poor. Our company has gone quite extensively into the building of trestles with timber decks and ballasted floors, and in all cases we buy the flooring the neat length and absolutely (as far as we can possibly govern it) prohibit the cutting of any of that flooring to a length other than that shown on the plan. We have a double creosoted timber trestle on one of

our divisions, put in 11 years ago, and in that time have not spent one dollar in the renewal of any part of the timber from the deck to the platform, which we feel is an excellent example of the good results to be obtained from treating timber. The resultant effects shown on trestles have been so good that we have during the past year built quite a number, and I think that in the future we will build a great many more, but we should follow as closely as possible and approve the recommendations of this committee. Their recommendations are good and strong, and they outline almost in detail the method that we are using and which we have found so effective. I therefore submit to the convention and the members of this association the necessity of ordering timber sufficiently in advance to be properly seasoned before treating, because unless it is seasoned we have simply thrown the treatment away.

E. T. Howson:—This subject is going to become of increasing importance from year to year. We hear a great deal nowadays of the shortage of timber. We know that the timber resources are being used faster than they are being reproduced. That, of course, is the argument for the treatment of timber. Many men go so far today as to say that we should at once resort to the use of other materials, but it seems to me that when such a relatively small proportion of the timber used by the railroads is treated, that the first consistent step is to treat the timber. Many of the roads are now using treated timber extensively, and some of them are using it exclusively, where timber is employed. I think there are now in addition to the approximately 100 timber treating plants in operation in this country, from 10 to 15 additional plants either under actual construction or in very immediate prospect. Therefore, the output of treated timber is going to show a rapid increase in the next few years. However, if the timber which is treated and which is turned over to maintenance officers is not properly installed, if the treated shell is broken in installation, and those injuries are not given first aid treatment in the field by the application of hot creosote, as Mr. Andrews has pointed out, or by other expedients, the money that is expended for that treatment is absolutely wasted, because the minute that the shell is broken even in a small way the rest of the treatment is of no effect, because, as with the cable, the treatment of that timber is only as effective as its weakest point, which is the unprotected portion. Those instances

which the committee has pointed out of the abuses of treated timber are all too common on the average railroad, not because of deliberate intent, but because of lack of thought. I have seen many such instances and the rest of you have also. The overcoming of those practices, or rather, their correction, resolves itself into a problem of education, the education of the individual workman and of the foreman and frequently of the supervisor of bridges himself as to the actual detriment and injury which will follow the careless use of treated timber. We are going to be obliged to use our timber more economically, if for no other reason than because of its increasing cost. I think we all realize that the price of timber is going to gradually increase, making it a more expensive material. Therefore, we are wasting a more valuable material if we injure it unnecessarily. That indicates the need of precautions such as the committee has pointed out, and as has already been brought out in the discussions, precautions to prevent the waste of that material, because any unnecessary abuse leads to a waste. The problem is one of education, of getting the workman and the foreman to realize the value of the material they are using and protecting it against the driving of holes into it unnecessarily, the sawing off of ends and various other things that are all too common. If the members of this association carry that message to their men, they will have gone a long way towards arresting the shortage of timber by using that which is available.

R. C. Henderson:—I think Mr. Andrews' suggestion to order the material some time in advance of building the bridge is a fine one, but I would go a little farther and recommend that we keep a sufficient supply on hand to take care of some of our work that cannot be anticipated. I think that we will be way ahead by doing that. We find that in several cases from year to year, we need to rebuild a bridge or a good portion of it, that we didn't figure on the year before. I have in mind one bridge that we had only about two months to figure on, and I think that we should have enough material on hand to provide for such cases.

J. H. Markley:—On our trip to the convention over the Southern I noticed a treating plant owned by the railway company where they use the dipping process. I would like to learn what success they have with it.

F. J. Conn:—We have two such plants. One is permanent

and the other portable. One of the outfits is located at Ferguson yard, consisting of two tanks, each 4 ft. wide, 30 ft. long and 2 ft. deep, made of wood and lined with galvanized iron. Steam pipes are placed in the bottom with protection strips over them to prevent the timbers coming in contact with the steam pipes. The creosote is heated only to 180 deg., in order not to harm the fibers of the timbers being treated. The timber remains in the tanks 12 to 15 minutes and should be turned several times, and to make a good job of it the timber must be dry. If the timber is of inferior quality and not properly seasoned the process is not a success.

The portable outfit consists of a steel tank or vat 4 ft. wide, 18 ft. 3 in. long and 1 ft. 6 in. deep. To set it up we simply dig a trench over which the vat is placed, banking earth around the vat, put up an old smoke stack at one end and fire at the other. It requires very little fire to keep it at the required temperature. The timbers are handled with a single block and rope with the aid of timber hooks. We sometimes redip the lumber in cold creosote which leaves a heavier coating on the surface. The portable outfit is particularly handy where ties for steel bridges have to be framed on the job, as in this way they can be treated after the cutting and framing is completed.

Our bridge timbers are practically all cut from the heart timber of the long leaf yellow pine, and the treatment preserves any sappy portions and keeps out the weather; besides the timbers are not so apt to check in hot weather. When we buy treated timbers in the market we are bound to get a considerable portion of loblolly pine which is of inferior quality and the expense of the lumber and treatment is much greater than when we buy the best quality of lumber and treat it ourselves.

A Member:—I would like to ask if anyone here has had experience with what is termed the brush treatment. We have been informed that some are using that method, applying from one to three coats. We have so far not used treated timbers but have just begun to try treatment by the brush method.

Hunter McDonald:—I feel that I can throw a little light on the matter of brush treatment. I spent about $5,000 in applying Carbonoleum Avenarius to bridge timber and plank about 25 years ago, both being treated by the brush method, applied hot. The life of the square timber was less than that of untreated timber. On the other hand, where the treatment was applied

to 1-in. plank, it was successful, and some of the plank is standing today in a fence and is still in good condition. I don't believe that any treatment of heavy timber is effective except that by impregnation. While I am on my feet, I want to call attention to another matter that has come up in my experience. In the year 1900, I noticed the success in the preservation of life of the covering of stringers and other trestle timber, stringers especially, on the Cincinnati Southern railroad. I went home determined to apply the same thing on our own line. I inaugurated a campaign of putting galvanized iron over the stringers and caps on every structure that was rebuilt. As far back as 1887 we had applied galvanized iron over intermediate caps where the second bent supports the top bent, the top post being doweled to the intermediate cap and placed directly on the galvanized iron covering. In 1900, these intermediate caps, which were made out of ordinary pine, were all in perfect condition. I have now quite a number of such caps on our branch lines where we have double deck work built of round red cedar poles. The intermediate caps were put on in 1898 and every one of them is sound today, having been preserved by the galvanized iron. The iron has not been changed in that time.

I recently had occasion to recommend the application of a creosoted ballasted deck on a trestle about 1,400 ft. long in West Tennessee which needed strengthening. In passing over the road lately, I found the work in progress. I stopped and examined the stringers which had been covered with galvanized iron for 20 years. There were holes through the iron where the ties had been doweled to the stringers and bolts passed through the guard rail, tie and stringer. Ninety percent of the stringers that were taken out were sound and fit for service again. I regretted that I hadn't strengthened the floor by the addition of untreated timber, widening the galvanized iron to 34 in., and placing a creosoted ballast floor on top.

The galvanized iron doesn't prevent the water entirely from entering the timber, but it does exclude the sunshine and much of the water, and the top surface of the timber is almost entirely free from checks, which, to my mind, explains its very effective preservation. I wrote a paper on this subject about 10 years ago and published it in the Engineering News, in which I outlined our experience at that time and the result of my latest observations in the matter, and on account of the very high price of creosoted

material which is almost prohibitive at the present day, I have discontinued the use of the creosoted stringers wherever our timbers at present have been covered with galvanized iron, and in strengthening the floor have added chords of untreated timber, applying over these a deck of 5-in. by 9-in. by 13 ft. creosoted timber and ballast floor. Much of the untreated timber used for these chords is taken out of structures that have heretofore been covered with galvanized iron, which have either been filled or on which creosoted ballast decks have been placed.

J. H. Markley:—I have been a very strong advocate of protecting the stringers in that way. I have one bridge where the stringers were on for 17 years, and the stringers have remained entirely sound. I have three bridges approximately 300 ft. long where the deck is covered with galvanized iron. When this was done, some 12 or 14 years ago, we did it at the expense of $1 per ft. On account of the high expense of iron now we, of course, cover the caps and stringers only, and we find they last twice as long as if they were not covered.

E. K. Barrett:—I will give you the experience of the Florida East Coast during the years of 1895 and 1896 with the dipping method for preserving timber. We spent about $40,000 in testing out this method by building tanks, running steam pipes through them, and picking up our timber and dipping, after framing. My experience in that line was that the treatment forms a shell, which will run anywhere from 1/8 to 1/4 in. thick, and in pine so treated at the end of five years we found the center of the stick a bunch of mush. One other objection as I see it to treatment by immersion is that it deceives the man inspecting the timber. The crust will appear to be perfectly good. The timber will appear to be just as sound as the day it was put in, but when you take a timber bar and prod it you may find nothing but a shell left.

The Secretary:—I think that would depend a great deal on the quality of the lumber used, and its condition at the time of treatment. The dipping process is not always a failure. Its success would also depend to some extent on the kind of chemicals used.

Geo. W. Rear: (By letter)—Timber is not creosoted just for fun, nor to furnish jobs for experts like Doctor von Schrenk. It costs a lot of money, so there must be some real reason; it will preserve the life of timber almost indefinitely. But it will not

unless it is properly treated and then properly handled—and this means even after it is built into the structure. The creosote treatment only forms a more or less thin skin on the outside of the timber and any cutting that will expose untreated material is bound to result in premature decay, probably rendering it little better than it was before treatment.

In inspecting creosoted structures that have been in service 25 to 30 years, many decayed pieces are found and in practically every case the cause can be traced to the cutting that took place in framing and placing. Some of this cutting is the result of improper framing; some may have been unavoidable and much of it was just simple foolishness.

"Butchered" creosoted timber will sooner or later tell its own story, and while you may get away with it for a long time, your sons will be sure to find out what a gump the old man was.

There is no good reason for cutting creosoted material, except to cut piles to the desired height after they are driven. All framing, even to the last bolt hole should be done before the material goes into the retort and any one who cuts into it thereafter should be called on to answer for it. Of course, now and then, in spite of rules and threats, some cutting is bound to take place and when this is done the cutter should immediately try to hide it so no one of the next generation will find it out. This is best accomplished by giving the cut portions repeated applications of hot creosote oil until thoroughly saturated.

Gangs handling creosoted material should be equipped with suitable kettles and a supply of creosote. When heads of piles are cut they should be saturated with hot creosote and then given a coat of hot tar or asphalt. If the sides of the pile project beyond the edge of cap they should be chamfered so water will not run under the cap.

We can furnish copies of our rules for handling creosoted material.

STANDARD FORMS FOR BRIDGE INSPECTION

REPORT OF COMMITTEE

A questionnaire circulated last year by the Committee on "Methods of Bridge Inspection Under Present Conditions" asked for specific data as to whether regular forms were customarily used in bridge inspection, as to the manner of recording field notes, and as to whether a record was made of the condition of members separately or in groups. The questionnaire also asked for information regarding the disposition of notes subsequent to the inspection, and the availability of old notes for inspectors in making succeeding inspections. There was also an inquiry as to whom the reports resulting from the inspection were made, and if special forms were used for that purpose. A request was made for copies of all forms used in connection with the bridge inspection.

In the report of the committee, emphasis was placed on the multiplicity of forms submitted and diversity of manner of conducting inspection, due primarily to variance in the form of operating organization. All the data collected by last year's committee were available for the use of the present committee, and all this information, together with the results of last year's work as embodied in the report, has been utilized in the work at hand. In presenting to the Association at this time a report on suitable forms for inspection purposes, it is necessary to direct attention to some of the outstanding features as mentioned in the report of last year.

The forms submitted were various, not only as to substance, but also as to size, quality of paper, style of binding, kind of printing, and duplication process utilized. The particular form of operating, organization maintained and the personnel thereof was found to have a marked influence on the kind of forms adopted by the various roads. Again, the physical characteristics peculiar to each line governed to some extent the character of the forms used. Emphasis was placed on the desirability of saving the inspector unnecessary work in the field and placing in his hands all available data as an aid. The consensus of opinion was found to be decidedly in favor of the narrative form of field notes. It was also developed that by all means the inspector should have before him while making the inspection a sketch, diagram, or consist of the structure. Notes of previous inspections to serve as a guide to instant recommendations were also considered quite necessary, and forms for reporting and summarization were deemed no less important than the forms for recording the notes in the field.

The Requirements

It became very evident to your present committee early in its work that since no set of forms heretofore submitted would answer the requirements, any scheme which might now be proposed for universal adoption must be radically different from those heretofore devised. To fulfill all the needs and serve as a standard pattern, any series worthy of recommendation must conform to the following principles:

1. Facility in recording notes and saving the man in the field all unnecessary and onerous labor is a first requisite.

2. A diagram, sketch, or caricature of the structure to be inspected is a distinct necessity.

3. Provision for accurately recording conditions and findings which can be interpreted correctly in a review of the notes by anyone at any time subsequent to the inspection is essential.

4. Clarity of reference in the notes to any particular member so

that the thought of the inspector cannot be misconstrued is of prime importance.

5. Utilization of the notes for maintaining correct office records of the consist of structures presents the best and most economical method known.

6. Provision for the compiling of field notes in a readily accessible form for subsequent use and future reference in the office is imperative.

7. A minimum of labor and expense must be involved in equipping the inspector with a concise and compact record of the consist of structures and findings of previous inspections.

8. The inspection is only the first step in the maintenance of structures, and the inspector's notes form the basis of the entire program of work. Forms, therefore, must facilitate the work of compiling bills of materials, making requisitions, and the issuance of shipping directions without error or confusion.

9. Any common standard proposed must be adaptable to all railroads regardless of mileage or form of operating organization, sufficiently comprehensive to cover all types of structures, and adequately elastic to permit of general or detailed expansion.

10. Simplicity and economy consistent with the end sought dictate that the number of forms be a minimum.

Details of the Work

With these premises as a guide, the work was undertaken. Some scheme of forms embodying sketches of structures was first considered. This immediately suggested the segregation of metal from wooden bridges. The sketch system was finally abandoned as entirely impracticable. The matter of manipulating heliographic processes of duplication was studied in connection with the work. Final recourse was had to the method of symbolic reference and forms worked out along this line.

As the work and study progressed, it was evident that, by this method, one style of forms could be made to cover every type of bridge structure used. In other words, the scheme could be made universal regardless of type or magnitude, first because every known type could be represented by a symbol, and second because the method permitted of expansion to cover any length of bridge and every kind of construction. Having once decided that this was the only method which could be made to fulfill all the given requirements, it only remained to adapt it to a convenient and compact form for the inspector's use.

The essence of the scheme is order—a place for everything and everything in its place, with the place so distinctive as to be readily distinguished from everything else in view. This can always best be accomplished where so much information of a similar nature is involved by enclosing the space assigned to any particular portion thereof in distinctive outline. The difficulty was in restricting the necessary information to the available space. Many schemes were tried before the final shapes and sizes were found satisfactory, and as is to be surmised, many unsuccessful efforts were made before a place could be found for every bit of information necessary for the inspector to have. The final result must of course be a compendium of the complete office record so arranged as to serve just as well as could a detailed structural plan.

Great difficulty was also encountered in symbolizing the different types of structures and kinds of construction. The symbols, as finally adopted, consist usually of the initial letter of the word or words by which the structure or kind of construction is customarily described. Therefore, the letters or figures in the symbols used mean something and are not merely letters or figures selected at random. It is to be observed that in conformity with the scheme, symbols for types not illustrated can be formed readily.

Due consideration was given to the expense of printing and wastage of paper. Any form out of the ordinary can generally be reproduced

most cheaply by the zinc etching process, using the draftsman's design as an original. This process is especially advantageous where illustrations are used in combination with ruling and subject matter; in fact it presents a latitude wholly impossible in ordinary hand or linotype composition and is no more expensive of execution.

The binding of forms into books of a fixed number of pages is wasteful and extravagant since it is impossible to proportion the size of books to the number of structures or to the available space required for their inspection. Then, too, there are frequent changes, through retirements or additions, in the number of structures occurring on any one district or branch. The scheme of forms herein proposed permits the use of the exact number required with the minimum waste of space.

Perhaps the most troublesome feature in maintaining a correct office record of the condition and consist of wooden bridges and trestles is in securing accurate reports of work done. Consequently, records do not often truthfully tell the story very long after construction. Regular inspections provide the way for verification and further details of reports previously rendered. To facilitate this verification, as well as to note changes in consist not reported at all, was one of the controlling factors in the design of the forms.

The Results

Complete fulfillment of all requirements rendered the task a rather complicated problem, the nearest solution of which we are able to return is embodied in the set of forms constituting Appendix "A."

Form 1000 is the outside front cover of the inspector's book, made up for each district or branch in advance of the regular inspection.

Form 1001 is the key to structural types and kinds of construction with the symbols to be used in the designation thereof. This should preferably be printed on the inside of the front cover in an inverted position so that when the book is opened it will be erect for instant reference. Owing to the very elementary scheme of symbols adopted, only one page of types will be required for each book. Hence this form need not be printed on the reverse side of the other forms as has been suggested. Moreover, the reverse side of the pages may be found convenient for the continuation of field notes, and should therefore be left blank. It is suggested that each railroad make a sheet of types and symbols to suit its particular needs. Only the idea is here illustrated.

Form 1002 is the central form of the set. On this form, in as many sheets as necessary, should be entered all the required information as to type, consist or makeup of the structure taken from the office records. The information should preferably be entered on the form by a typewriter since the spacing of lines and symbols was arranged expressly for the purpose. The transcription of the data from the records to the form should be as complete as possible, not overlooking sizes and dimensions, for it is from this form, after the inspector has recorded his field notes thereon, that estimates and bills of materials are compiled and a working program arranged to carry out the inspector's recommendations without recourse to other sources of information. The form, when returned by the inspector, will serve to correct or verify the office record, and is to be made the basis for concurrently keeping up the history of the structure in all its details.

Form 1003 is for the inspection of those structures such as culverts, cattle guards, and buildings for which Form 1002 is not readily applicable, and the inspector's advance information accompanied by such illustrative sketches as may be necessary should be entered thereon. It is suggested that an entire sheet be devoted to even the smallest structure. The idea being that every bridge, culvert or other structure on the district should be covered by one or more pages of the book pertaining to that district.

After the data for any one district or branch have been transcribed from the records to Forms 1002 and 1003, the sheets covering the vari-

ous structures are to be arranged in geographical order and bound together by removable fasteners, such as "Chicago Screws" or "McGill Fasteners," using Form 1000 as a front cover, Form 1001 as a front fly leaf if it is not printed on the inside of front cover, and a half page length of medium weight tag board for a back. The inspector is to be furnished with a stiff covered portfolio of sufficient capacity to accommodate the thickest built-up book and provided with a pocket next to the back cover into which is inserted the short tag board back of the booklet. The inspection of a district or branch results immediately in a self-contained book of field notes without surplus pages and ready for the compilation of estimates and bills of material, for the correction of office records, or for such disposition as the practice of the particular railroad may dictate. It is to be observed that the inspector should be supplied with extra copies of the forms in the event that conditions are found necessitating the insertion of additional pages in proper geographical order.

No set of printed instructions to inspectors is recommended, the thought being that each railroad should handle this feature to suit its individual requirements. In any event, such instructions must be considered as a matter separate and distinct from the forms. We think, however, that if printed instructions are issued they could with advantage be printed in form and size for mounting on the inside of the front portfolio cover.

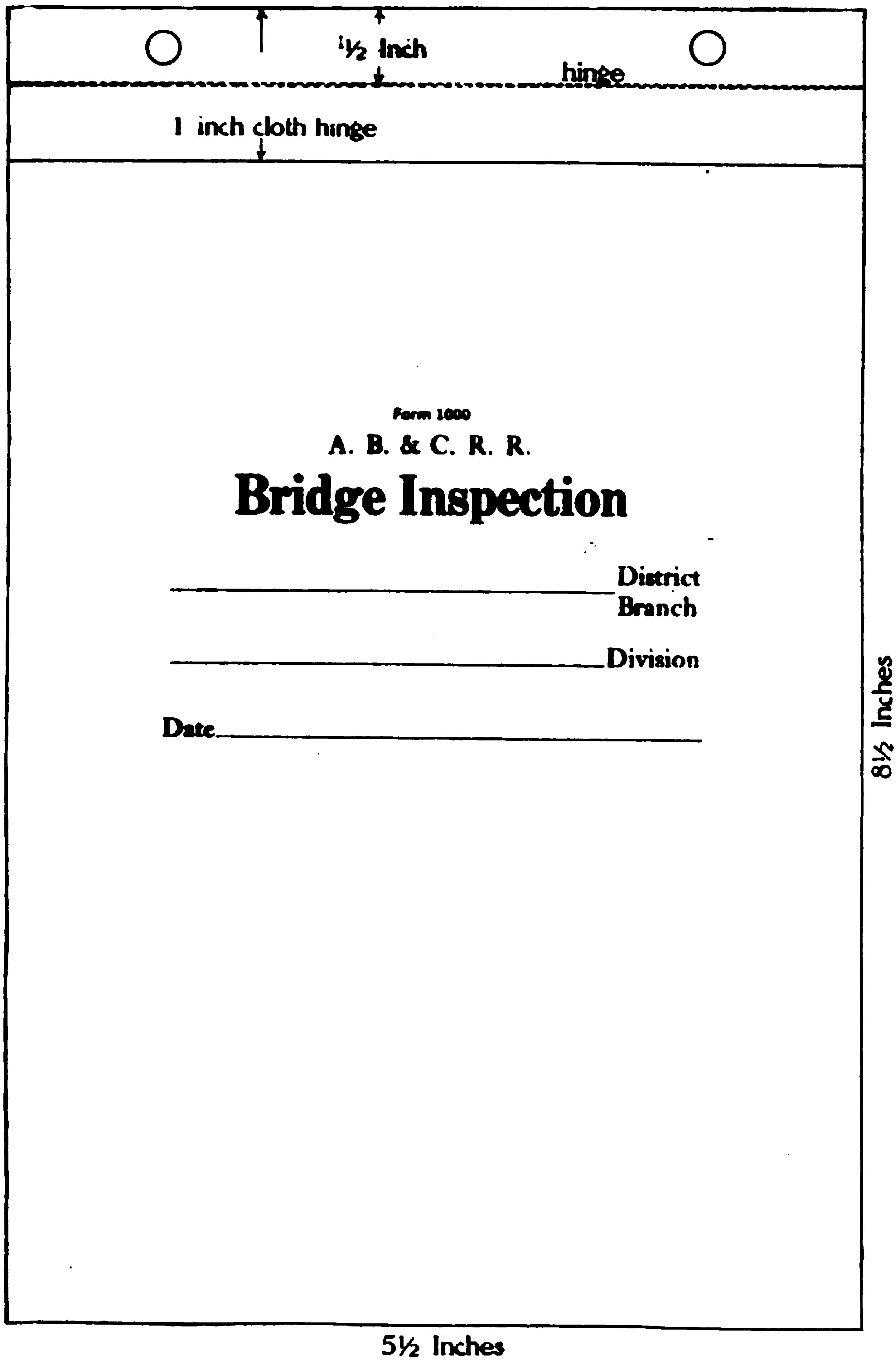
Form 1004 is designed for use in reporting both detailed and summarized results of the inspection. No suggestion is made as to the movement of this form for the reason that practice and kind of operating organization will doubtless govern the disposition of the inspection report.

Bridge and Culvert Record

The maintenance of a concurrently correct office record of bridges and culverts is so interwoven with their periodical inspection that a consideration of the one can scarcely be separated from the other. While the instructions to the committee made no mention of record forms, the study given to the inspection forms prompts a suggestion as to a scheme for office record of bridges, culverts, and other line structures. The committee therefore takes the liberty of suggesting for the consideration of the members a card system record of structures, and for this purpose presents the forms constituting Appendix "B." The general notes accompanying these forms in the appendix will doubtless be sufficiently explanatory without further comment.

In all of the work of the committee, the thought uppermost in mind was that too much importance could not be given to a complete, accurate, and authentic history of each bridge, culvert or line structure throughout the entire length of its serviceable life, beginning with its original installation and ending with its retirement or replacement. The results are respectfully submitted for your consideration.

Arthur Ridgway,
G. E. Boyd,
W. A. Clark,
J. T. Harvey,
R. H. Helick,
C. W. Lentz,
M. E. Nelson,
J. J. Taylor,
Committee.



Form 1000

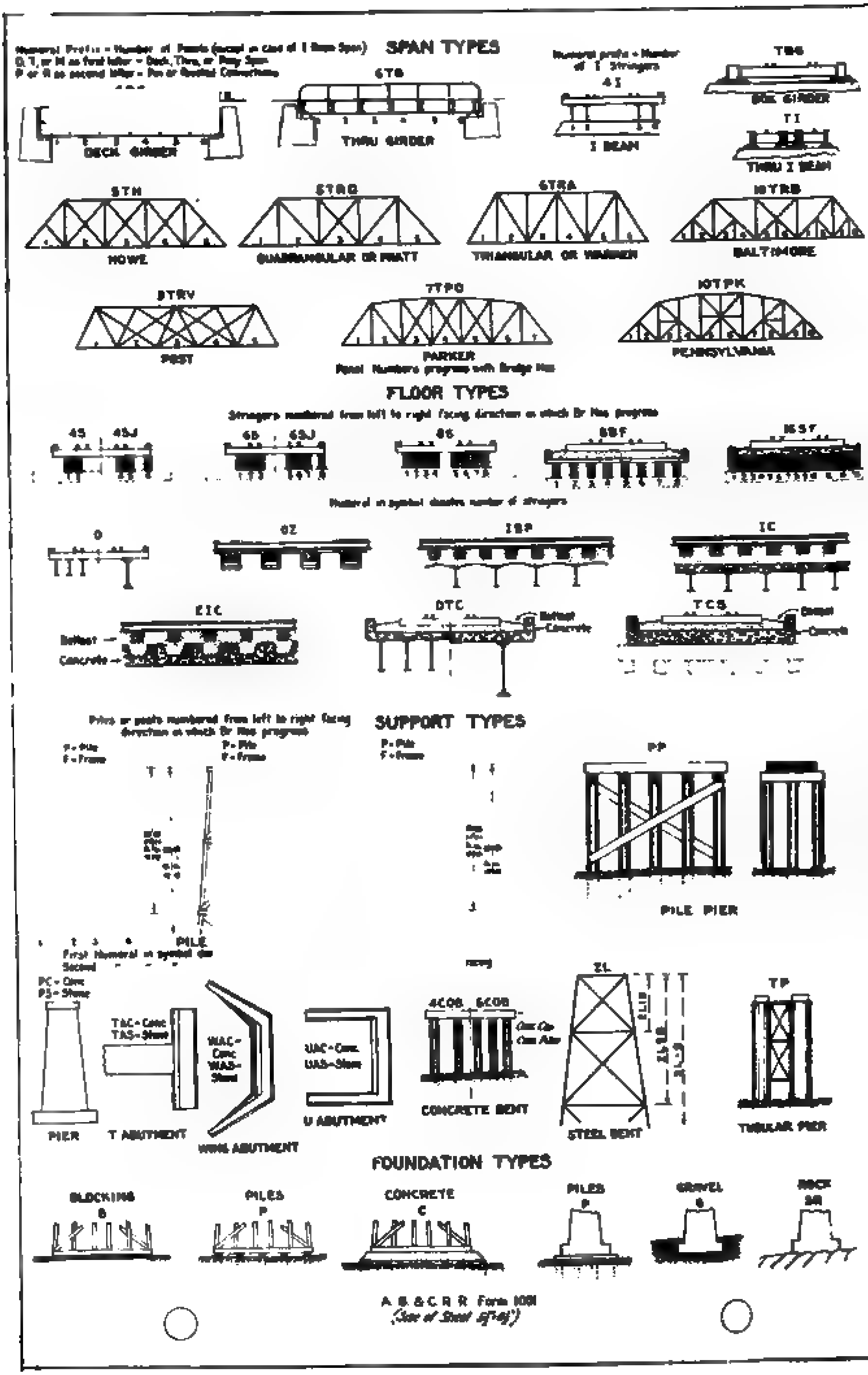
A. B. & C. R. R.

Bridge Inspection

____________________ District
Branch

____________________ Division

Date____________________


SPAN TYPES
6TG
THRU GIRDER
DECK GIRDER
4 I
I BEAM
TDG
TI
THRU I BEAM
5TH
HOWE
5TRQ
QUADRANGULAR OR PRATT
6TRA
TRIANGULAR OR WARREN
10TRB
BALTIMORE
POST
7TPQ
PARKER
10TPK
PENNSYLVANIA
FLOOR TYPES
4S
4SJ
6S
6SJ
8S
8BF
16ST
IC
EIC
Ballast
Concrete
DTC
TCS
SUPPORT TYPES
P-Pile
F-Frame
PP
PILE PIER
PILE
PC-Conc
PS-Stone
TAC-Conc
TAS-Stone
WAC-Conc
WAS-Stone
UAC-Conc
UAS-Stone
4COB
6COB
SL
TP
PIER
T ABUTMENT
WING ABUTMENT
U ABUTMENT
CONCRETE BENT
STEEL BENT
TUBULAR PIER
FOUNDATION TYPES
BLOCKING
B
PILES
P
CONCRETE
C
PILES
P
GRAVEL
G
ROCK
SR
A B & C R R Form 1001

(Size of Sheet 5½"×8½")

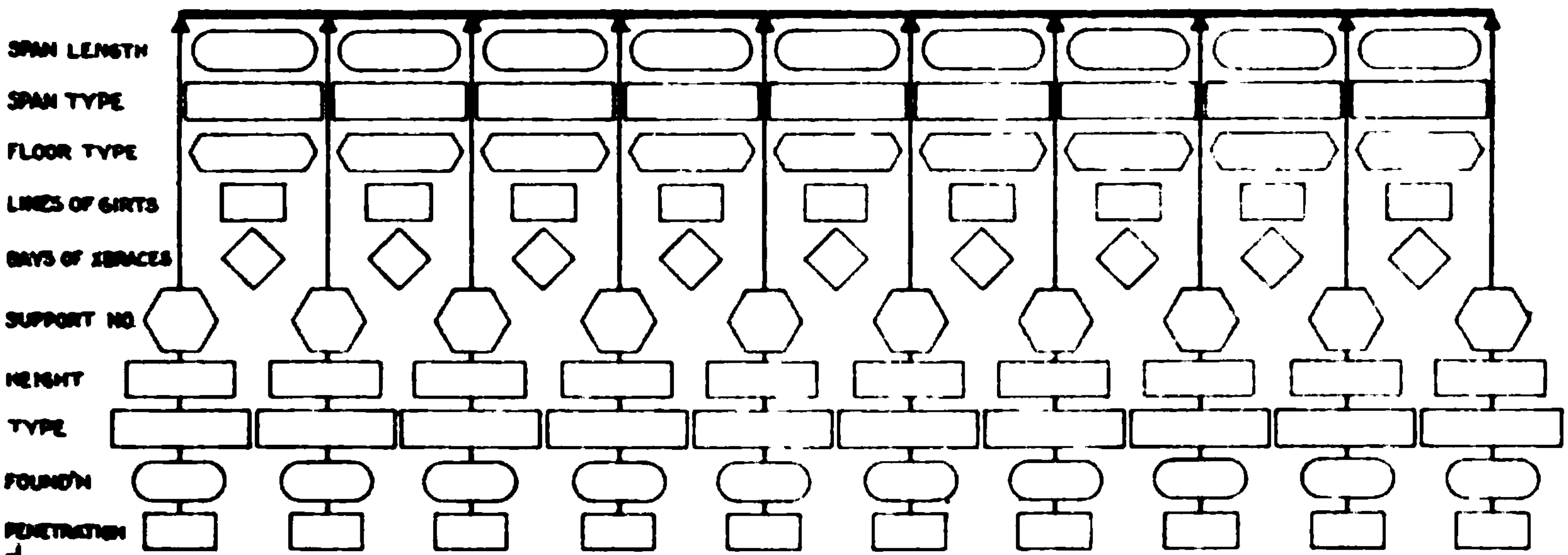
A. B & C R R Form 1002

BRIDGE INSPECTION

BRIDGE NO.............. .... {DISTRICT / BRANCH} .... DIV'N. YEAR BUILT..........

NUMBER SPANS........ NUMBER TRACKS...... NUMBER {TRUSSES / GIRDERS} .... BASE OF RAIL TO GROUND ....FT

TOTAL LENGTH.. ....FT ON......SHEETS THIS SHEET NO.....COVERS........LIN FT NOTE.— SUPPORT NOS PROGRESS WITH BRIDGE NOS



SIZES & KIND OF MAT'L.

GUARDS .... CAPS .... SASHES..............................

TIES............................ SPACED....... POSTS.............................. GIRTS..............................

STRINGERS............................ SPACED...... SILLS.............................. X BRACES..............................

FLOOR PLANK.............................. SWAYS.............................. DUMP PLANK..............................

(Entire Sheet below this line to be quadrille ruled in light blue with 1/10" spaces)

CONDITION

RECOMMENDED WORK

MATERIAL REQUIRED

BRIDGE NO...................... DATE...................... ....INSPECTOR

(Size of Sheet [illegible])

A. B. & C. R. R. Form [illegible].

BRIDGE INSPECTION

SPECIAL AND MISCELLANEOUS STRUCTURES

CLASS OF STRUCTURE .... NO. OR LOCATION .... {DISTRICT / BRANCH} .... DIVISION

CHARACTER AND SIZE ....

ILLUSTRATIVE SKETCHES (Entire Sheet below this line to be quadrille ruled in light blue with [illegible]" spaces)

CONDITION

RECOMMENDED WORK

MATERIAL REQUIRED

STRUCTURE NO. DATE .... INSPECTOR

A. B. & C. R. R. Form 1004 (Size of Sheet 11"×17")

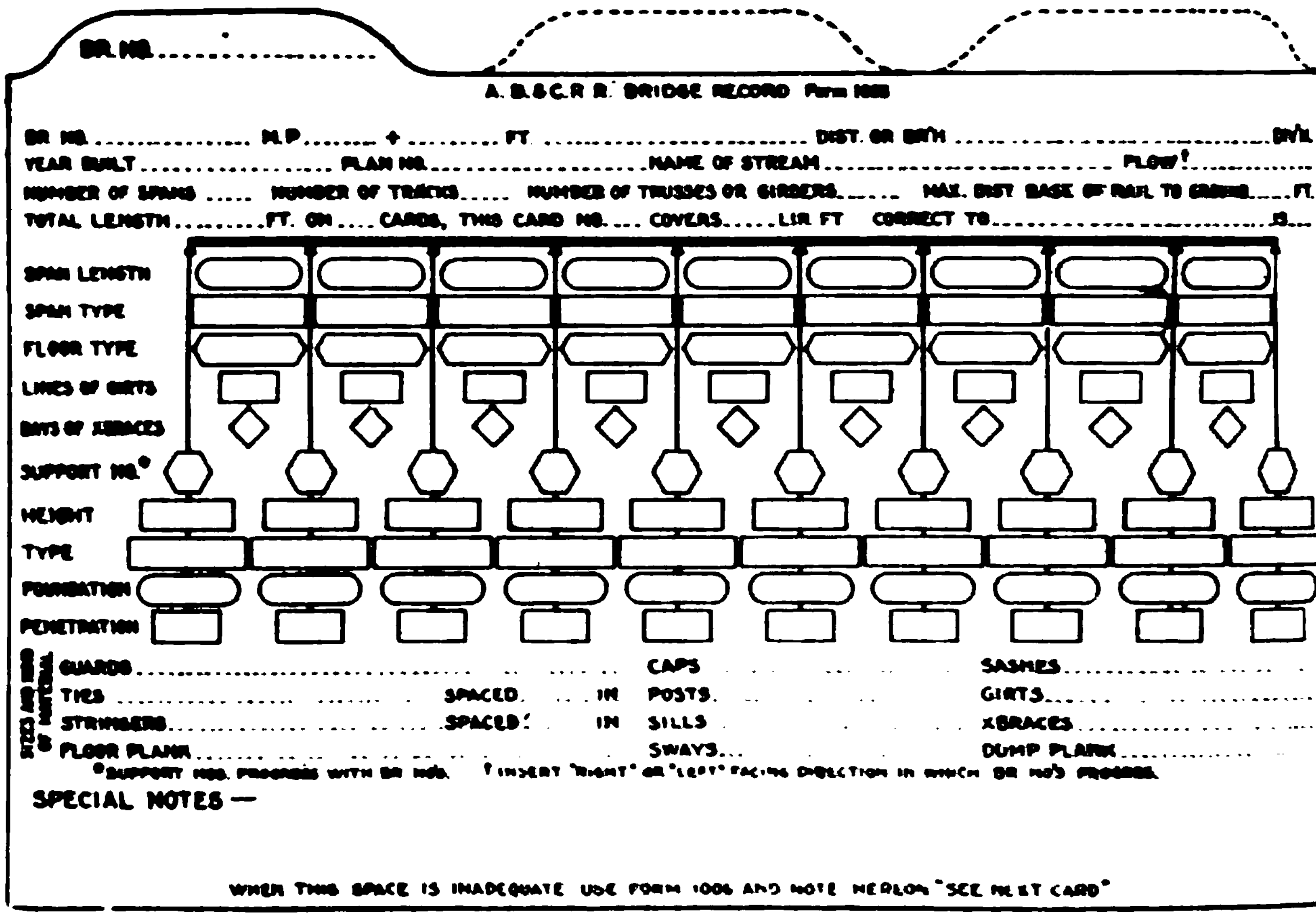
BRIDGE INSPECTION

Use this form both for detailed requirements of each structure and for summarizing cost on District or Branch

.... {DISTRICT / BRANCH .... DIVISION

DATE .... INSPECTOR

BRIDGE OR CULVERT	MATERIAL REQUIRED				SALVAGE	MATERIAL NET COST	LABOR COST	TOTAL NET COST	DIVISION OF COST		
	KIND	SIZE	QUANTITY	COST					EXPENSES	R. & E.	IND. & CO'S.



BR. NO.

A. B. & C. R. R. BRIDGE RECORD Form 1005

BR. NO. .... M.P. .... + ... FT. .... DIST. OR BR'N .... BR'L

YEAR BUILT .... PLAN NO. .... NAME OF STREAM .... FLOW† ....

NUMBER OF SPANS ..... NUMBER OF TRACKS ..... NUMBER OF TRUSSES OR GIRDERS ..... MAX. DIST. BASE OF RAIL TO GROUND ..... FT.

TOTAL LENGTH .... FT. ON .... CARDS, THIS CARD NO. .... COVERS ..... LIN. FT. CORRECT TO .... 19...

SPAN LENGTH

SPAN TYPE

FLOOR TYPE

LINES OF GIRTS

BAYS OF X BRACES

SUPPORT NO.*

HEIGHT

TYPE

FOUNDATION

PENETRATION

SIZES AND KIND OF MATERIAL

GUARDS .... CAPS .... SASHES ....

TIES .... SPACED ..... IN. POSTS .... GIRTS ....

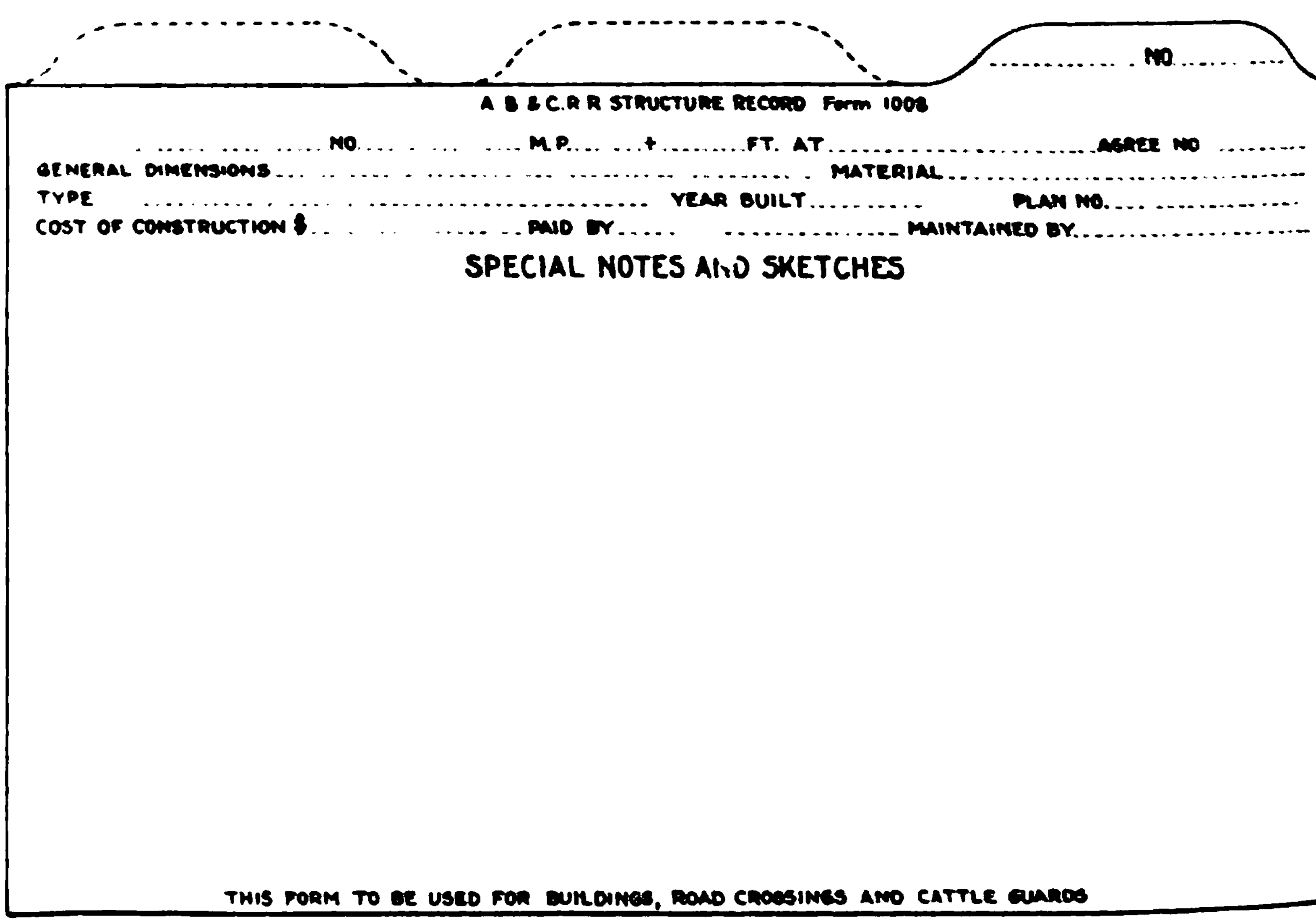
STRINGERS .... SPACED ..... IN. SILLS .... X BRACES ....

FLOOR PLANK .... SWAYS .... DUMP PLANK ....

*SUPPORT NOS. PROGRESS WITH BR. NOS. †INSERT "RIGHT" OR "LEFT" FACING DIRECTION IN WHICH BR. NO'S PROGRESS.

SPECIAL NOTES —

WHEN THIS SPACE IS INADEQUATE USE FORM 1006 AND NOTE HEREON "SEE NEXT CARD"



NO. ....

A. B. & C. R. R. STRUCTURE RECORD Form 1008

.... NO. .... M.P. .... + ... FT. AT .... AGREE. NO. ....

GENERAL DIMENSIONS .... MATERIAL ....

TYPE .... YEAR BUILT .... PLAN NO. ....

COST OF CONSTRUCTION $ .... PAID BY .... MAINTAINED BY ....

SPECIAL NOTES AND SKETCHES

THIS FORM TO BE USED FOR BUILDINGS, ROAD CROSSINGS AND CATTLE GUARDS

A. B. & C. R. R. BRIDGE RECORD Form 1006

BR NO............M.P....... +.........FT ....DIST OR BR'H ....DIVISION

SPECIAL NOTES AND SKETCHES

USE THIS FORM ONLY WHEN "SPECIAL NOTES" SPACE ON FORM 1005 IS INADEQUATE. WHEN USED, WRITE "SEE NEXT CARD" ON FORM 1005

A. B. & C. R. R. WORK RECORD Form 1009

RECORD OF WORK PERFORMED

..............................* .... M.P........ +........FT. ....DIST OR BR'H. .... DIV'N.

DATE	DESCRIPTION OF WORK	COST

* WRITE "BRIDGE", "CULVERT", OR NAME OF STRUCTURE AND NUMBER OF SAME HERE

CULV. NO. ....

A B & C R.R. CULVERT RECORD Form 1007

CULV. NO. .... M.P. ...+........ FT. .... DIST. OR BR'H. .... DIVISION

TYPE .... PLAN NO. .... SIZE .... LENGTH .... FT. YEAR BUILT ....

BASE OF RAIL TO TOP OF COVER .... FT.* AREA DRAINED .... ACRES AGREEMENT NO. ....

COST OF INSTALLATION $ .... PAID BY .... MAINTAINED BY ....

KIND OF HEADWALLS .... NAME OF STREAM .... FLOW* ....

SPECIAL NOTES AND SKETCHES

* INSERT "RIGHT" OR "LEFT" FACING DIRECTION IN WHICH BR. NOS. PROGRESS

GENERAL NOTES —

ALL FORMS TO BE PRINTED ON 5"×8" CARDS THIN AND FLEXIBLE ENOUGH TO BE HANDLED IN TYPEWRITER.

IF CONSIST OF BRIDGE, CULVERT, OR STRUCTURE IS CHANGED, TAB ON FIRST CARD SHOULD BE CUT OFF AND NEW CARDS, WITH FULL RECORD OF CONSIST BEARING DATE OF CHANGE IN CONDITIONS, PLACED IN FILE IMMEDIATELY AHEAD OF PREVIOUS RECORD CARD.

SPECIAL NOTES —

FORM NO. 1005 ON WHITE CARDS, SOME WITH AND SOME WITHOUT INDEX TABS.

IN CASE A BRIDGE HAS MORE THAN NINE SPANS TWO OR MORE CARDS MUST BE USED SO THAT COMPLETE INFORMATION FOR EACH SPAN AND EVERY SUPPORT OF THE BRIDGE WILL BE SHOWN AND SUPPORT NUMBERS WILL RUN CONSECUTIVELY FOR ENTIRE BRIDGE.

CARDS WITHOUT INDEX TABS WILL BE USED AS CONTINUATION CARDS FOR SAME BRIDGE, AND WHEN SUCH ARE USED THE LAST SUPPORT NUMBER ON ONE CARD WILL BE REPEATED AS FIRST SUPPORT NUMBER ON THE CARD IMMEDIATELY FOLLOWING.

FORM NO. 1006 ON WHITE CARD. WHEN NECESSARY TO USE THIS CARD, FILE IT IMMEDIATELY FOLLOWING FORM 1005 TO WHICH IT REFERS.

FORM NO. 1007 ON YELLOW CARDS WITH INDEX TABS.

FORM NO. 1008 ON BLUE CARDS WITH INDEX TABS.

FORM NO. 1009 ON WHITE, YELLOW, AND BLUE CARDS TO CORRESPOND IN COLOR WITH THE BRIDGE, CULVERT OR STRUCTURE CARDS WITH WHICH THEY ARE RESPECTIVELY USED.

THIS CARD TO BE KEPT CURRENTLY POSTED AND FILED IMMEDIATELY BEHIND ALL THE OTHER CARDS FOR EACH BRIDGE, CULVERT, OR OTHER STRUCTURE. INSPECTION WILL BE CONSIDERED AS WORK DONE AND NOTATION WILL BE MADE ON THIS FORM SHOWING DATE PERFORMED.

AMERICAN RAILWAY BRIDGE AND BUILDING ASS'N

COMMITTEE ON FORMS FOR BRIDGE INSPECTION

A SUGGESTED CARD SYSTEM RECORD OF BRIDGES AND BUILDINGS

DENVER, COLO JUNE 15, 1920

DISCUSSION

(Standard Forms for Bridge Inspection)

A. Ridgway:—I don't think we should take time to read this report. In fact, it is too complicated anyway to express it in the way we wish to express it by words or written explanation. I was chairman last year of the committee on "Bridge Inspection Under Present Conditions," and we collected at that time, a lot of information on the various forms for bridge inspection. At the Cleveland convention we mentioned how various those forms were, scarcely any two of them being even similar. That diversity of forms rather complicated our work this year. We first thought we might select one of them as a pattern and work to that, but after long weeks of study we concluded we would have to just set them all aside and work at something entirely new and different. The result we present to the association today in this report. We can hardly expect a representative of any one line to say that these forms are all right at first glance, because they are in the first instance so different as to make us rather reluctant to say they are all right, and in the second instance, they are really involved in the whole matter of bridge inspection, and current maintenance work. I have tried to explain in the text of the report just how these forms should be handled, and to describe the method by which they ought to be used. It is a little difficult to express just what is meant, so I have brought along three or four copies of the inspector's book as we think it should be, and we can just pass these around.

Now in connection with the inspection reports you will find our suggestion for a bridge and building record. I suppose we were outstepping our authority when we included this, but the matter of a bridge record in the office was so involved with the other matter of bridge inspection that we could scarcely refrain from saying something about it. Our study of the bridge inspection forms led us also into the study of the maintenance of bridge records. I believe we all understand the importance of keeping an accurate office record in chronological order during the entire life of any structure. As an instance of the importance of that may I cite an incident that happened on our own line. You remember reading in 1904 of the Eden disaster where a passenger train went through a trestle bridge. The bridge carried the track over an arroyo which was absolutely dry about 99½ per cent of

the time, but a cloudburst occurred in the drainage area, and swept away a county bridge, which, in turn, carried out the railroad bridge just before the train reached the point of crossing. Now the point is, with such a disaster we were asked to give the history of that bridge, both in the coroner's investigation and afterwards in the railroad company's investigation, and determination of their responsibility for the accident. We found that by our records we could give the detailed history for about 40 years past. But our bridge records were kept then as now in book form, in which every change made,—every bolt that is put into the bridge each year is recorded. But the keeping of such a record is a laborious matter and does not permit of as much facility in making current entries as some other means. So we think that a far better system would be the cards which we have suggested in connection with the report. I am sorry that I have not a sample of the cards to show you. The explanation appearing with the last of the cuts is sufficiently concise and clear I think to give a correct understanding of the idea.

Now the committee doesn't ask anybody to adopt these forms at this time, but we would like to have your criticism on them.

R. H. Reid:—I was just looking over this little chart and it looks good to me. If the plan is carefully followed out, it will build up a very good record of the bridge structures on a railroad in time. It is possible that some railroads have fairly complete records. We have complete records on the New York Central of every bridge and culvert on the line. We have the detailed plans and shop drawings of all of our iron and steel bridges, and we have, of course, the additional information that is gained from year to year on inspection. While we are lacking detailed plans of some of our older masonry structures, we have detailed plans of all our more recent structures of that class. A record of this kind might be desirable even for masonry structures, although this is designed primarily for metal and wooden bridges. A record which can be applied to railroads that do not have complete records of their bridges, is vitally important, and it looks to me as if this would furnish a good, complete record, in conjunction with the periodical or annual inspection notes.

We make an annual inspection on the New York Central, although a large part of the line is inspected twice a year, but

we make the regular open form notes on that inspection largely because we have the complete record; we don't need the information shown here, in our inspection notes, but wherever necessary we make sketches on the inspection trips, to show any special features that our plans might not bring out readily. The open notes, of course, can be made rapidly, to cover all the points necessary to bring out, including the recommendations, etc., for repairs or renewals, and, for getting the necessary authority for the expenditure of the money.

I arrived so late yesterday that I have not had time to go through this report in detail, but this card that Mr. Ridgway mentions looks very good to me. I see no reason why it is not practical. But this apparently is made for a card index. Why couldn't the same arrangement be printed on paper to go into a loose leaf binder and be taken into the field for the inspection notes? On our inspection trip I have a copy of the bridge record, that I write up myself from time to time. I re-write it about every five or six years, as there are enough changes on any division ordinarily in that length of time to make it advisable to re-write the record. It is a hand-written record, for my own convenience; I write it by hand in order to get it into as small and compact a space as possible, and carry it in a loose leaf cover made by the I-P Company, of Kansas City, with pages of a size 4 in. by 7 in. The record sheets are ruled with columns for certain information, and for the inspection notes, single ruled sheets for ordinary writing, having seven lines to the inch, to make it as compact as possible. This card could be printed on a sheet of any size, simply a matter to bring it down to whatever scale is necessary, and the sheets could be punched for loose-leaf covers and made very convenient for field use. I think it is a good idea to take this form into the field for the inspection notes. While you are there, with the bridge before you, you can make all the notations necessary and the more complete inspection we can make on the job in the field, the more real and accurate information we will have, and the more valuable it will be.

A. Ridgway:—I want to read you some criticisms made by members of our committee. W. A. Clark of the Duluth & Iron Range was a member of the committee, and he says, " My principal objection to the final draft of the report would be that it seems to be contemplated that form No. 1002 must be filled out for each structure and each inspection, regardless of whether

or not any changes have been made in the structure since the previous report. It would seem to me that there is no good reason why, in individual cases, this form could not be used for two or more inspections, which would not only save the labor of filling in the principal data regarding the structure, but would also give the inspector the benefit of the previous inspection notes." Now I answered Mr. Clark in this way,—That this form No. 1002 can be printed on ordinary white paper or can be printed on tracing cloth. If you have an old structure that you know won't change and can't change in succeeding years, you could fill the record of that structure in on the tracing cloth and make a paper negative and use that white print over and over again.

You remember that last year we said that by all means an inspector should have before him a picture of each structure as he went to it in the field. Now that was the principal thing that we tried to work out in these forms. We couldn't make the sketch because bridges are so diversified in character and outline that we couldn't get any typical sketch that would represent all of them. Therefore we finally decided on the plan of using symbols and I think after becoming a little bit accustomed to form No. 1003, with all the information for all the spans and all the sub-structure of each bridge, you will find that that diagram will be just as clear as if you had a sketch of the bridge.

Now we have also a criticism from Mr. Wood, an inspector on the Boston & Albany. "First," he says, "it would be necessary to have the road furnish forms, loose leaf note books and report blanks radically different from those used at present. This would be quite an expense, and I do not believe the road would care to stand it." Well, you have to have a re-print of the old forms when they become exhausted. It wouldn't cost any more to get these printed than it would the old ones re-printed. "The interval between inspections would have to be lengthened as under the proposed system it would be impossible to do any work in the field on stormy or very cold days, as the inspectors, if required to carry a copy of the previous inspection with him and check it at the bridge, the first rainy day would spoil the note book." I don't see why it would spoil this book any more than it would any other book.

Another thing that we brought out last year was that by all means the inspector should be furnished the notes of the previous inspection so that he might have some idea as to the

rate of deterioration which took place in the structure since the last inspection. This would give him some idea of what he might expect in the succeeding six months or a year.

"Third, the size of the form does not correspond with any of our standard forms, and while it is supposed to be pocket size, it will be necessary to carry it in a tool kit or have a pocket made to order to fit. A loose leaf note book would not last very long carried in a kit with inspector's tools."

Well, gentlemen, we tried to make this as small as we could. We can not get a miniature edition of these forms. This was designed so that a sheet of paper 17 in. by 22 in. would cut to the right size without waste. We had the idea of economy in our minds. I can not make it any smaller.

"Four, the system of symbols is too elaborate to suit conditions on the Boston & Albany. I do not think much of any system which substitutes letters for words, as mistakes are too apt to happen. For example, if a bridge is a 6-panel through girder, it is much better in describing, to write the words out than to represent them by numbers and letters, as '6-TG,' because about the only person who would be expected to memorize the symbols would be the inspector and if anyone else wanted to read the report intelligently he would be obliged to take the key to the symbols and interpret it by letter." Now it is easier to write 6-TG than it is to write 6-panel, through girder, isn't it? We figured that these symbols are elaborate. If we were making them for our own road we would probably cut out half of them. We just tried to make them as complete as possible so that the idea would be clear as to how the symbols might be applied to structures which didn't appear here or cover every kind of construction. The symbols, as you know, we suggest being printed on the inside of this cover of the book, covering one district of bridges, and since the letters and the figures in the symbols mean something, I fail to see how there could be much confusion regarding the matter.

That is all the criticisms I have had so far.

R. H. Reid:—Mr. Ridgway has mentioned several points that I think are entitled to further favorable consideration. The point he mentions of the inspector having copies of the former inspection records, I think is good. We have that in our inspection trips on the New York Central. I have the notes with me on inspection trips, of not only the preceding inspection, but in

several cases, of two, three and four previous inspections, sometimes for three years back, in the case of important structures where changes are going on, in order to follow those changes. We maintain a regular, follow-up system and keep tab of all the changes on all the structures.

Mr. Ridgway said one criticism was that on some structures there are no changes from year to year. We have comparatively few structures on the railroad that can be called actually permanent structures. Even the steel structures are only temporary. They are subjected to ordinary rust, atmospheric conditions, smoke, salt brine rust, and similar conditions which will wear a good many of them out in from 20 to 30 years. I don't believe the average life of steel structures on the New York Central Railroad west of Buffalo has been over 30 years. Some of the masonry structures last longer than that, but many of our stone structures, such as abutments, arches and boxes, have shown evidence of distress under the increased weight of the motive power. Such changes could be noted on the records from year to year where changes occur. Some of the large structures are changing from year to year; the soil changes under them, and where shale rock occurs the frost gets under and loosens it up and spring freshets take it out.

I note on another page of the report that this diagram apparently is provided for loose leaf form. This page is about four and a quarter by a little less than seven inches, but I think the form could be made 4 in. by 7 in. without making much difference, and that size could be easily carried in a loose leaf cover, and carried in a pocket. I have carried these loose leaf books for 5 to 10 years, with the same covers, replacing the sheets where necessary, and re-writing the record every 5 or 6 years and changing out and filing the inspection pages. Those folders can be carried in the breast pocket or side pocket of a coat, or even a hip pocket, so they are always available on the job, to make whatever notes are necessary, and refer to former notes and follow up the changes. Incidentally, I might say it is worth while to print those forms on a good quality of paper. Our inspection records and inspection notes on the New York Central Line West are made on bond paper, that will wear almost indefinitely, and will stand considerable handling. The bridge records in that book, after the book has been re-written, are filed away for permanent reference, and the inspection notes are

also filed. We have had occasion to refer to those notes sometimes 15 or 20 years after they were made.

The record idea, as brought out in this report, I think is good. It is not an easy matter to make it uniform on all roads. If we are going to make records uniform, the first thing is to make the methods of inspection fairly uniform. Find out some method that seems to meet the conditions the best of any that has been proposed and so far as possible adopt that method of inspection. It is a difficult matter for any committee to work out a system of inspection notes and records that will meet all conditions on all kinds of inspection.

President Weise:—If there is nothing further on that, we will follow our usual custom and accept this report for printing in our proceedings. Mr. Ridgway, the association thanks you and the members of your committee for the splendid work you have done on this report.

THE REPAIR AND MAINTENANCE OF TANK HOOPS

REPORT OF COMMITTEE

The committee has received very satisfactory reports from over 45 railways of the United States and Canada, including many of the large systems. Many of these lines have greatly reduced the cost of maintenance and eliminated much work and many hazardous conditions by the use of round or half round hoops. Many lines are, however, still using flat hoops and some of the lines which have adopted the round or half round hoops still have some flat hoops in service.

A serious objection to flat hoops is the fact that a satisfactory inspection cannot be made without removing them from the tank, due to the fact that they often rust or corrode on the inside and become very thin and weak without any apparent deterioration from the outside. Cases have been reported where tanks equipped with flat hoops have collapsed a few days after a superficial inspection had been made.

Regardless of these facts, few roads seem to have uniform or standard instructions for the inspection of tank hoops, especially flat ones, and the hoops are seldom removed unless they show some indication of weakness on the outside surface when the tanks are painted. It is almost the general practice for the supervisor of bridges and buildings or the water service foreman to make an annual inspection of tanks. This is made superficially only; the hoops are not removed. The tanks are painted every two to four years and more often if appearance requires. In nearly all cases, however, the hoops are well painted both inside and out, and the connections well oiled or painted before the tank is erected, which of course is proper and is done with good results.

Only two lines were found to have specific instructions for the removal of flat hoops for inspection. These instructions require the removal of all hoops every year in one case and every two years in the other case, at which time all hoops are scraped and painted and all necessary repairs or replacements taken care of. This, of course, is an absolutely safe practice.

A great variation in the intervals at which tanks and tank hoops are painted is found on various lines, ranging from every two years to every eight years while many roads report that tanks and tank hoops are painted when needed. There are several good reasons for this variation, among which are the climatic conditions, tanks being located where they are exposed to gases and other injurious elements; in many cases, no doubt, the general standard of maintenance is restricted by financial considerations and is confined to necessities with very little provided for refinement and appearance. It would seem to be unsound economy to neglect in any detail the proper maintenance of tanks or tank hoops. If only for appearance, to say nothing of safety and a reliable water supply, a well painted and maintained tank reflects the general standard of maintenance to the traveler and the general public. The tank is a part of railroad equipment occupying an attractive position and will well return the expense of first class maintenance. To say that tanks are painted when needed may at first seem to be an indefinite statement, but if they are painted WHEN NEEDED, certainly no fault can be found. This emphasizes the necessity and value of careful and intelligent inspection.

Almost without exception, it is the practice when erecting tanks to apply at least two coats of paint to both the inside and outside of hoops, usually using red lead for the first coat, the hoops being well cleaned, of course, before painting. Most roads having their own standard paints use them for the last coat. Paint made of lampblack, asphaltum, var-

nish, linseed oil, turpentine and Japan drier has been found very satisfactory. The connections, lugs, etc., should be well oiled or painted as often as necessary.

The size and number of hoops have been well determined by design and experience, flat hoops ranging from $\frac{3}{16}$ in. to $\frac{1}{4}$ in. in thickness and from $2\frac{1}{2}$ in. to 6 in. in width, depending on the size of the tanks, and round and half round hoops varying from $\frac{7}{8}$ in. to $2\frac{1}{2}$ in. in diameter.

Of the 45 lines reporting on this subject, 25 have practically adopted the use of round or half round hoops and report, as previously stated, that they are far superior, the advantage being that a more satisfactory and thorough inspection or examination can be made of the hoops. Much less surface is exposed to the weather and other injurious elements; they can be drawn up more readily; they are provided with more convenient and substantial connections, and from experience have been found to last longer. In fact, it is stated that they will last as long as the tank under any conditions. These statements have been made in many instances with an emphasis that reflects genuinely satisfactory results from several years' experience.

The use of chafing irons between the hoops and tank staves at the connections has been found of great benefit. They are usually made of the same dimension material as the hoops and from 28 in. to 40 in. in length.

The committee has gone into the method of scaffolding and concludes that the most convenient method, when tanks are painted but hoops not removed, is to swing scaffolding from the pinnacle of the tank over the edge of the roof, rigged so it can be raised and lowered from the scaffolding. When hoops are removed, however, it is necessary to stage from the ground around the tank. Under extreme conditions these methods are not applicable. That is, on some roads in the warmer climates tanks have no roofs, therefore, there is no pinnacle. Scaffolding however can be swung from the top of the staves. On some lines in cold climates where tanks are housed in to protect them from the frost, permanent staging can be maintained between the housing and tanks, which is often done.

The placing of putty between the top edge of the hoop and the side of the tank all around before tightening and also filling the space between the bolts and the lugs at the connection of the hoop parts, has given good results, especially under bad conditions. In many cases this practice has been found practically to eliminate the rusting of hoops on the inside.

Complaint has been made in the data secured on this subject that the hoops manufactured in later years are not of the same high grade, tough and durable material as used in former years. The complaint is not general but no doubt has some merit as this is true of many building materials.

The repair of tank hoops is taken care of effectively, generally, by the replacing of hoops or parts of hoops with new or good second hand ones. When the entire set of hoops on a tank has deteriorated to a point where they still have a fair margin of safe life left, the element of chance may be eliminated by placing additional hoops, which is often done. When hoops or parts of hoops are replaced, the hoops removed can be taken to the shop and in many cases repaired if they are not too badly deteriorated, thus providing repair parts.

The maintenance and repair of tank hoops is an extremely important detail of railway maintenance, yet the committee cannot say that sufficient attention is generally given to it. On the other hand, like all details of maintenance, maximum service should be obtained from tank hoops and this can be secured by judicial and intelligent inspec-

tion. Therefore, the committee urges that this feature of this subject be given as much consideration as the conditions to which a tank is exposed would require.

F. A. Benz, B. R. & P.,
E. C. Zinsmeister, B. & O.,
C. W. Wright, Long Island,
G. W. Welker, Southern,
J. H. Grover, Santa Fe,
A. W. Smith, Can. Nor.,
J. L. Winter, S. A. L.
Committee.

(DISCUSSION)

(Tank Hoops)

The Secretary:—This subject was before the Denver convention in 1910. Those who have the proceedings for that year will find some valuable information on tank hoops.

G. W. Andrews:—This subject has been threshed over from time to time, not only by this association but by the American Railway Engineering Association. But I have noted particularly here that this committee seems to be very favorably inclined towards the round hoop. Now on first consideration we might think that the round hoop would be the best because it is so easily inspected, but we don't want to lose sight of the fact that the round hoop leaves a space on top which becomes filled with dirt and cinders and provides a receptacle for moisture which is injurious to the staves. I know from my own personal experience a number of cases where round hoops were drawn so tight as to sink them into the wood at least a full sixteenth of an inch. The result was that the fibers of the wood stave were broken and decay started. Just as soon as you break the fibers of the wood or crush the face of the staves you start decay. You can not draw flat hoops tight enough to injure the fibers of the wood, but it can easily be done with round hoops. I have always opposed the installation of the round hoop on our road, and so far I have been successful, except in a very few instances where the tank was erected before we were notified. But in each and every such case that has come to my notice the result has been as I have related. Even though 25 roads out of 40 have gone to the round hoop, we want to be careful before we advocate that as a recommendation of this association.

I know as well as the rest of you how difficult it is to get puddled wrought iron, yet we can get it if we pay for it, and if we get it we can have flat hoops made that will last as long as

any round hoop that was ever made. Only a short time ago we took down a tank that had been in use for 28 years. The original hoops were on the tank when taken down, which were not deteriorated 10 per cent. Samples of those hoops were on exhibition in the Coliseum at Chicago some time ago. It would have been difficult for any man to have told on casual inspection, or even on close inspection, which was the under side or which was the outside of the hoop. If we can get the wrought iron hoop or even one of good mild steel we will have but very little trouble with it, but ordinary steel deteriorates rapidly.

As far as inspection is concerned, that is covered in our general instructions, which necessitate taking the hoops off every time the tank is painted and renewing defective hoops, painting the hoops that are still good on the under side and putting them back on the tank and then painting the face of the hoop as the tank is painted, and where we have followed that rule, we have had absolutely no trouble from collapse of tanks nor have we had any serious breaking of hoops, and I feel that if that practice is carried out in full there will be but very little difficulty or trouble experienced from the use of the flat hoops. We are paying today $1,450 for a 50,000 gal. tank, and we can afford to spend a couple of hundred dollars in removing and re-placing defective hoops and save the tanks for a number of years more. If these instructions were carried out by every man, which we are trying in every way to have done, we would have very little difficulty.

The Secretary:—I can not quite understand the policy of a railroad in trying to save from $20 to $40 in the cost of flat steel hoops over those made of wrought iron and then spend $300 to $400 every time the tank is painted in removing steel hoops for the purpose of inspection and painting them on the under side and putting them back, when it is positively known that the old fashioned wrought iron hoops have been in use from 25 to 35 years without ever having anything done to them except painting on the outside when the tank was painted at regular intervals. I recollect very well when steel hoops were purchased for standard size water tanks because the wrought iron hoops would cost $19 more than a set of steel hoops. At the same time it was nothing unusual to hear of the collapse of a tank on account of being furnished with steel hoops that were from 5 to 8 years old. That has been argued over and over again in our back proceed-

ings. I am aware that the subject under discussion is not that of the best material for hoops but, at the same time, what is the use of arguing how best to maintain and repair hoops when we should spend the time in discussing the proper quality of material for hoops? Even in the case of round hoops it might be policy in the end to furnish iron instead of steel. Time only will tell whether a wood tank bound with round steel hoops is going to last as long as one bound with flat wrought hoops, and we do know positively the length of service the latter have given in years past. This matter is not disposed of just because a great number of roads have decided to adopt the use of round hoops as a standard. I still vote on Mr. Andrews' side in this matter.

H. R. Gibson:—I have listened with a great deal of interest to this discussion of the hoop question and I would like to ask Mr. Andrews if he has any figures to show the life of a flat hoop as compared with a half-round hoop?

G. W. Andrews:—I am very sorry to say I have not. Several years ago, however, we designed an oval hoop, 3 in. in width, but when we endeavored to get those hoops rolled we found the price so exorbitant we had to give it up. We have since found that we could get a narrower hoop than that without difficulty, and I believe that the oval or the half-round hoop would be far superior to the round hoop of equal area. The half-round or oval hoop overcomes the principal difficulty that I have referred to in connection with the round hoop, that is, that they lie flat to the wood; the upper and the lower edges are thin; decay could be easily detected, and no sediment can rest between the hoop and the tank. I haven't been able to find it yet, but if we can get a half-round or oval hoop of sufficient strength that would be economical as compared with the other hoops, then I wouldn't hesitate a minute to advocate that type.

H. R. Gibson:—We have on our division a tank over 30 years old which has half-round hoops and they have given excellent satisfaction.

G. W. Andrews:—Inasmuch as that is under the direction of the department with which I am connected, I am all the more strongly inclined towards the half-round hoop. A number of people have been trying to convert me to the use of the round hoop for a number of years. I don't express these views as arbitrary at all. I am still open to conviction, but so far I have not been converted. I examined a tank only recently in the vicinity

of Baltimore that had been erected only a few years ago with round hoops and I found evidence that could not be controverted of the conditions that I have explained, that is, the hoops had been drawn so tight they had penetrated the wooden staves, had broken the fibers and had started decay and the decay was seriously aggravated by the accumulation of dirt and dust constantly moist on the top of the hoop.

I recall a tank at Morgantown, W. Va., that had been up for 28 years. The flat iron hoops that were originally put on it were still on when it was taken down. It was a white pine tank of 50,000 gal. capacity and the hoops were so good that they were used on the erection of a new tank in preference to new ones and the new hoops laid aside for repairs to other tanks. That was several years ago and the hoops are still in use after 34 years' service.

F. J. Conn:—I suppose we are using every kind of hoop that is in existence up to date on our division. Back in 1895 (nearly 26 yrs. ago), I erected two tanks with flat hoops, varying from 3 to 6 in. in width and from 3-16 to ⅜ in. in thickness. We got the best iron obtainable. A couple of years ago the management became uneasy and thought those hoops were rusting, and so I had them all taken off, cleaned, painted and put back. The rust that was found did not amount to anything. The tanks have to be renewed again, while the hoops are good for further use. We have had steel hoops, round, flat and half-round, and we have trouble with them all the time. I order the best iron I can get from Chicago; it is not the best grade, but it is the next best, and costs 7¾c per lb.

C. R. Knowles:—Up to 4 or 5 years ago I was inclined to favor the flat hoop, chiefly because I hadn't had much experience with the round hoop, but after an investigation that covered a number of railroads, and a very great number of tanks, I reach the conclusion that the latter was decidedly the better for a water tank. There are a number of stock arguments against round hoops; I used them just as fervently as anyone until I knew better. One was that moisture would collect in the top of the hoop and cause decay. I examined a large number of tanks and in none of them did I find any moisture or any appearance of decay or any dirt collected to amount to anything. Another argument is that the round hoop will crush the fiber of the stave and promote decay. I have never found any indication of decay

on account of the crushing of the fiber. At Belleville, Ill., there is an old tank that has practically fallen down; the staves were held by round iron hoops that I am told had been in service for over 30 years. Of course they were genuine wrought iron, and had they been flat hoops it would probably have been the same story.

At Chicago Junction, on the Great Western, just outside of Chicago, is a tank at the roundhouse that was built about 20 years ago, and originally equipped with flat hoops. The tank fell down about 10 years ago on account of the failure of the flat hoops, and when the tank fell it was necessary to renew about one-third of the staves. Their standard had been changed in the meantime and the new tank was equipped with round hoops. It was a cypress tank and the staves that remained good were put back on the tank and wherever the flat hoop rested against the surface of the tank decay had occurred. You can mark the line of the old flat hoops by the decayed spots in the tank. The new hoops have been in service for about 10 years and though very poorly maintained as far as painting is concerned, they are deeply pitted and grooved in places by corrosion, but you can tell at a glance that the hoops are still safe, and will be for a long time. I think the trend of the discussion has been against the round hoop, but I must say I am of the opinion that it is the style of hoop to use. Incidentally, I may say that the standard adopted by the American Railway Engineering Association provides for the use of round hoops.

G. W. Andrews:—I built tanks 40 years ago in the days when we sawed them out of the rough lumber and made our own flat wrought hoops and drove them down in the same manner that you drive hoops down on a barrel, and I have never yet found any cases where decay of the staves was caused by the use of flat hoops, but I have found on recent inspections of hoops on other lines and in the plants of individual corporations where the round hoop has been drawn so tight that it penetrated the wood, which, in itself, started decay immediately.

C. R. Knowles:—It is no doubt true that tanks have been damaged on account of the improper application of round hoops, but if round hoops are properly stressed and properly applied you will have no indentation of the wood, and consequently no damage resulting.

G. W. Andrews:—I will agree with you on that.

F. Gable:—We have used in my territory only round hoops for the last 10 years. I want to say that up to this time we have experienced no trouble whatever from breakage or decay. They are now standard on our road.

J. M. Staten:—I have had 65 years' experience with the flat hoops. When I was five years old I had to carry water, and we had flat wrought iron hoops all the time. Before we had purchasing agents we had wrought iron hoops. After we got purchasing agents we got any kind of hoops. If we were all paying for wrought iron hoops and got them we would never have any trouble with our tanks.

President Weise:—I was on the committee that Mr. Lichty spoke about that prepared a report 10 years ago on hoops, and it is quite interesting to note that we didn't settle the question then; it is still an open question.

THE USE OF ELECTRICITY FOR PUMPING

By C. R. Knowles
Superintendent Water Service, Illinois Central Railroad

While electricity has been employed to some extent as power for pumping at railway water stations for many years its use has not been general. It has long been apparent that electricity had its advantages for this class of service, but up to the past few years current has not been available at many outlying stations and where current was available the rates were often so high that there were but few places where electric power would show a saving in operation over steam or gasoline. Within recent years the production of electricity for commercial purposes has increased greatly and the extension of power lines has made it available at many points on our railroads at rates sufficiently attractive to warrant serious consideration, with the result that there has developed a considerable use of electric motor drive for pumping plants at water stations.

A motor-driven pumping plant with automatic pressure regulator or float switch control is specially suited to locomotive water tank service at many points because the tank may be kept full, regardless of variations in the demand for water, without any attention other than a periodical inspection of motor control and pump. It is also practical in some installations to have the station agent or local employe start and stop the pump by a remote control switch or push button. The standard control equipment now on the market is reliable and can be depended upon for pumping station service.

The cost of electric power for pumping is usually lower than the cost of the fuel that would be required by a steam plant, as the coal consumed at the average railway water station is from 4 to 6 times that necessary to generate the electricity required to pump the same amount of water. This is accounted for by the fact that with a steam plant there is a loss of fuel in getting up steam, banking fires, etc. Also as a general thing the pump in the average railway water station is not as efficient a machine as the large steam turbines commonly used in central power stations. Electric motor driven pumps have an added advantage over steam in lower first cost, and lower maintenance, while they are more compact, cleaner and easier controlled. An important factor in the comparative cost of a steam and electric plant is the housing. An electric pumping plant will require a building approximately one-third the size of that required for a steam plant of the same capacity. On the other hand, the difference in the cost of pumping by steam and by electricity is offset to some extent by reason of the current having to be carried over a transmission line with resultant line losses, together with the cost of construction and maintenance of power lines. Electric power also has a disadvantage where pipes and pumps are exposed to freezing temperatures since it is necessary to provide some method of heating the plant and where extremely low temperatures prevail constant attendance is often required to keep it from freezing during the winter months. Another point to be considered is the question of electric service interruptions due to storms or other causes. While the motor itself is reliable and can be further protected against failure by installing duplicate units it is not a prime mover and unless more than one source of power is provided it is liable to failure through interruption of power supply. This is particularly true where the source of power supply is from a small or heavily

loaded plant where trouble may be expected from variable voltage or frequency.

The development of the internal combustion engine using oil as fuel has been a factor in retarding the general use of electricity, as an electric motor can compete with the oil engine in operating costs only where the motor can be operated by automatic control, thereby eliminating the expense for constant attendance. The cost of current is usually based upon the nature of the demand as well as the amount of current used. A better rate may be secured where the load is uniform throughout the 24 hours than where the pumps are operated for only a few hours, and in many cases a still better rate for current may be obtained when the pumping hours are arranged so that the pumps may be operated on the off peak load. Contracts for electric power usually contain a charge dependent upon the aggregate horse-power of the motors as well as the stipulated charge for current. The charges for current are invariably based on a sliding scale of rates per k. w., the lowest rate applying to the greatest consumption of power. Rates for current vary widely, depending on the size of the central power station as well as the location and class of equipment in the power station. Electric drive is adapted to all types of power pumps, especially the centrifugal type as the motor can be connected direct to a centrifugal pump without belts or reduction gears.

The convenience and simplicity of a direct-connected motor and centrifugal pump make it one of the most desirable installations for tank service under conditions within the limits of centrifugal pump operation. Recent installations have consisted largely of this type of pumping unit, but failure to realize the limits of a centrifugal pump has unfortunately resulted in some unsatisfactory installations.

One middle western railroad has recently installed electric pumping equipment consisting of duplicate units, each having a capacity of 30,000 gal. per hour, the operation of the pumps being controlled by the height of water in the tanks. This plant replaced a steam plant which required the services of three men while the electric plant is operated by one. The cost for current about equals the cost of coal formerly used in the operation of the steam plant and the net saving is approximately $1,500 per year.

The pumps are two horizontal, single stage, double suction, split shell, centrifugal pumps with 5 in. suction and discharge openings, with bronze enclosed impeller and bronze fitted throughout. The pumps are designed to deliver 500 gal. per min. against 100 ft. total head, including 15 ft. suction head at 1,750 R. P. M., the mechanical efficiency being 66 per cent.

The motors are two 25 hp. horizontal, 3 phase, 60 cycle, 220 volt, 1,750 R. P. M. cross-the-line-type self starting motors. Motors and pumps are direct connected and mounted on the same sub-base. The control panel is of the Sundh type consisting of two overload time limit relays of the hand reset type, main line switch, phase protective relay, two-pole knife switch for hand operation, three-pole double throw knife, switch so wired that either motor may be operated but not the two together, double pole cross-the-line contactor for throwing the motor across the line and a Gage-type pressure regulator for operating panel by tank pressure. The pumps are fitted with a diaphragm by-pass valve for priming automatically, when operating under automatic control.

The pumps have been in operation 9 mo., during which time they have pumped 90,000,000 gal. of water at a cost of $1,523 for electricity, or $0.0169 per thousand gallons for power only, the current consumption being 47,870 K. W. H. at an average cost of $0.0318 per K. W. H., the total head ranging from 78 to 90 ft.

Operating Results by Months

Month	Electricity		Cost	Gallons pumped
January	5370 K. W. H.		$ 174.57	11,000,000
February	5820 K. W. H.		168.98	10,100,000
March	5650 K. W. H.		165.92	10,000,000
April	5440 K. W. H.		162.14	9,150,000
May	4940 K. W. H.		152.59	9,250,000
June	4870 K. W. H.		151.12	9,000,000
July	5430 K. W. H.		161.96	10,000,000
August	2270 K. W. H.	$ 28.92		
August	2260 K. W. H.	145.87	184.79	11,300,000
September	5820 K. W. H.		201.71	10,200,000
Total	47870 K. W. H.		$1,523.78	90,000,000

As an example of the comparative cost of pumping water with steam and gasoline the following figures show the results obtained at Dumont and Lake Mills, Iowa, on the C. & N. W. Ry. The installation at Dumont consists of a 5 in. by 6 in. triplex pump driven by a 3 hp. 220 volt, 60 cycle, 3 phase, 1150 R. P. M. motor, direct connected to the pump. The average consumption of water is 1,080,000 gal. per mo. The average current used in operating the electric pumps is 230 k. w. per mo. at a cost of $8.20, or an average cost of $0.0076 per thousand gallons of water pumped for electricity alone. This compares with an average cost of $47.66 per month or $0.0441 per thousand gallons for water pumped by the gasoline engine in use previous to the installation of electric pumps.

At Lake Mills the equipment consists of a single-acting deep well pump cylinder 5¾ in. dia. by 24 in. stroke which is operated by a pump jack driven by a 7½ hp. 60 cycle, 3 phase, 220 volt motor at a speed of 1,150 R. P. M. The consumption of water is approximately 1,500,000 gal. per mo. The cost of current averages $23 per mo. or $0.0156 per thousand gallons. The average monthly cost of operation and maintenance pumping by gasoline was $67.50 per mo. or $0.045 per thousand gallons. This would indicate that pumping by electricity will show considerable economy over the cost of pumping with the gasoline engine. A large part of the expense of operating a gasoline engine is due to maintenance and where a gasoline engine is operated by a station agent or his helpers there is no question of the economy of electric operation over the cost of pumping with gasoline.

Until recent years it was difficult to secure large quantities of water from wells without using an air lift which did not always offer the most economical solution of the problem. The development of the deep well turbine pump seems to have solved this problem to a large extent. The deep well turbine or centrifugal pump is particularly adapted to motor drive and installations of this type have proved very satisfactory.

Operating results covering a period of twelve months on a pump of this type are given herewith: The pump consists of a 15 in. 6 stage, turbine pump driven by a 40 hp. vertical motor, 440 volt, 60 cycle, 3 phase, 1170 R. P. M. During this period 183,850,000 gal. of water were pumped, using 151,390 k. w. h. at a cost of $3,724 for electricity, an average cost of $0.0246 per k. w. h. or a cost of $0.0202 per thousand gallons of water pumped, the total head being 160 ft.

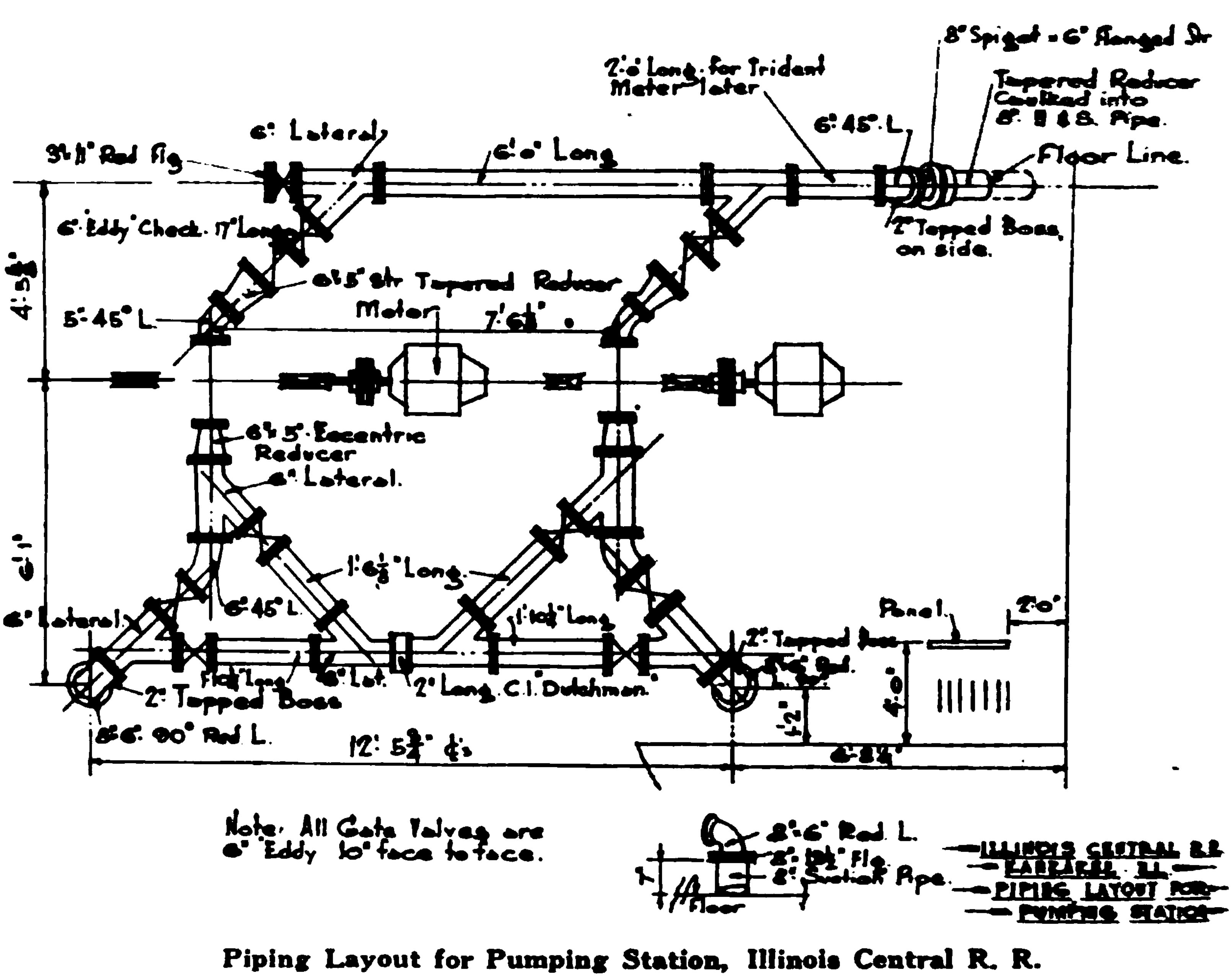
The efficiency as shown in shop test is perhaps higher than that obtained in field service, although there is no doubt that this type of pump shows very satisfactory efficiency.

While, under suitable conditions, electric drive has proved very satisfactory in railway water service at the same time it would be a mistake to fall into the error of considering it for every installation regardless of its suitability for the conditions of operation as there are many conditions where steam is preferable to electricity on account of the possibility of utilizing the exhaust steam for heating or other

purposes as well as for pumping. As stated previously the power cost for pumping with oil engines is almost invariably lower than for electric power. As a result the chief advantage that electricity possesses over an oil engine is the possibility of automatic or remote control with a resultant saving in the salary of attendants. As with other types of pumping installations the maximum reliability is not obtainable through the installation of a single unit and while the construction of duplicate units will, of course, increase the construction cost it is not difficult to justify the additional expenditure on the ground of insurance against interrupted service as well as reducing the maintenance expense due to emergency repairs which are often necessary with a single unit.

The shop test on the above pump showed the following results:

R. P. M.	Total Head	G. P. M.	I. H. P.	H. P. to Pump	W. H. P.	Eff,
1170	13.2	838	40.5	34.2	2.8	8.18
1170	31.9	817	40.6	34.3	6.58	19.2
1170	45.1	802	40.7	34.4	9.12	26.5
1170	59.0	774	40.8	34.5	11.53	33.4
1170	72.3	747	40.9	34.6	13.66	39.4
1170	86.4	725	41.0	34.7	15.8	45.8
1170	99.9	700	41.3	34.9	17.68	50.7
1170	113.0	671	41.7	35.2	19.14	54.3
1170	127.1	637	41.2	34.8	20.45	58.7
1170	140.6	612	41.2	34.8	21.7	62.3
1170	148.6	596	40.9	34.7	22.2	64.0
1170	158.1	567	40.8	34.6	22.65	65.4
1172	169.1	540	40.3	34.1	23.05	67.5
1178	182.0	502	39.6	33.4	23.05	69.0
1180	205.0	437	38.7	32.6	22.5	69.0
1182	223.0	328	35.4	29.6	18.5	69.4
1200	245.0	0	18.8	14.5	0	0



Piping Layout for Pumping Station, Illinois Central R. R.

Electric Pumping Station, Lake Zurich, Ill., E. J. & E. Ry.

Electric Pumping Station at Villa Grove, C. & E. I. R. R.

(DISCUSSION)

(Pumping by Electricity)

A Member:—I would like to inquire of Mr. Knowles if he has ever had any experience with tapping into a high voltage line, say a 30,000 volt line, and about what the expense would amount to. In connection with the report I do not quite understand what is meant by the limits of a centrifugal pump.

C. R. Knowles:—Under certain conditions there is little necessity of stepping down the current. If the conditions are favorable one may use electric current at whatever voltage happens to be available. It is not advisable, however, to use higher than 2,200 volts. Many of the cross-country power lines carry as high as 66,000 volts, but the majority of the lines for commercial service are rarely over 2,200 volts. I doubt if a power company would tap a 30,000 volt line without stepping down the voltage, a transformer would cost somewhere near $150 for each 30 hp. unit.

There has been a good deal of discussion on the subject of the limits of centrifugal pumps. Many engineers insist that the suction lift should not exceed 10 ft. We had a very interesting development in connection with our Kankakee installation. In order to make the pump fit the conditions we had to change the throat opening in the impeller several times. I know of one road that has thrown centrifugal pumps out and pronounced them a failure, simply because they did not suit the conditions which existed so far as suction lift and head were concerned. The pump should be designed to suit the conditions.

A Member:—That is due to the fact that they did not design the pump for the work to be done. In our city we have been using what are termed rotary pumps. We have in some cases as much as 1,100 ft. head. They put submerged pumps in at different stages in order to raise the water. They always use the 3-stage pump for high pressure city work.

C. R. Knowles:—We have fixed a height of 14 ft. as the suction limit. I do not mean to say that we have no centrifugal pumps operating with a greater suction lift than 14 ft., but on new installations we have established that as the suction limit. I know of a pumping plant on the Chicago & Eastern Illinois which is operating satisfactorily with a 20-ft. suction lift.

Arthur Swenson:—Have you experienced any trouble with air in the use of automatically controlled centrifugal pumps?

C. R. Knowles:—No. There are two methods of control. If the pump is too far from the tank, or trouble experienced with air, or fluctuations in pressure, a float control should be used with a return wire to the pump, but most plants will operate satisfactorily with pressure regulation. The pressure passes thru a gage contact on the board; the contact is mounted in the same manner as a pressure gage, the spring making a contact, operating a pilot switch which, in turn, operates a rheostat switch.

V. E. Engman:—In the air pressure do you experience any trouble with the pulsations of the pump?

C. R. Knowles:—You might have trouble with pulsations on a long line or a line supplying service for a terminal, for example, where a large demand would be made on the line before the water reached the tanks, which would cause a drop in pressure. Under those conditions a float switch should be provided, controlling the height of the water in the tank regardless of the pressure on the line; although with an air tank having the pressure piped through a line to the pilot control it would take up a lot of ordinary surges that might be caused through air in the line; likewise other interruptions to flow would probably be absorbed in the air tank.

F. W. Hillman:—How about ice?

C. R. Knowles:—You would experience the same results with ice on the float valve that you do with the ordinary float valves. They would have to be protected against ice.

R. C. Henderson:—I would like to ask Mr. Knowles what he considers a correct charge for power.

C. R. Knowles:—That is a pretty hard question to answer. There probably is no such thing in practice as a "correct charge" or rate. It is like the farmer who said when he saw the giraffe at the circus, "There ain't no sich animal." The usual power rates of the public service companies through the middle west are based on a fixed charge; for example, if you have a 30-hp. motor you pay for 30-kw. hours per month at the maximum rate, which usually ranges from about 11 cents to 3 cents. The rate for current depends entirely on the consumption.

Another factor entering into the rate is the type of central power plant. If it is an economical plant such as most public

utility companies operate, you would get a lower rate. Of course, with the country lighting systems where they have old type non-condensing engines, and probably unload their coal by hand and haul it two or three miles in a wagon you would expect to pay a higher rate. It is impossible to fix any particular rate.

F. E. Shanklin:—We have at Belle Fourche, So. Dak., a 10 in. well 568 ft. deep, furnished with 200 ft. of 6-in. drop pipe, a 5¾ in. by 54 in. cylinder and 200 ft. of 3 in. ash pump rods. It is equipped with a Fairbanks Morse 20-hp. motor, pump jack, pump head and a heavy duty pump. The water is lifted 190 ft. to the surface and has 40 ft. of 4 in. discharge pipe. The pump will deliver 20 in. of water in a standard tank per hour. The daily consumption of water used at this station is about 25,000 gal., and the cost for electric power averages approximately $15 per mo. The motor sits back from the pump jack about 14 ft. and is driven with an 8-in. 2-ply leather belt. This pump was installed 8 yrs. ago, and so far as I can learn has never given any trouble in any way with the exception of burning out fuse plugs occasionally. This pumping station causes the least trouble of any on the Black Hills division and in my opinion electric power is so far ahead of anything else for pumping that I hope to see the day when all pumping stations are equipped with motors where electric power is available.

MAINTENANCE OF TIMBER DOCKS

REPORT OF COMMITTEE

F. C. Baluss, Chairman
L. J. Anderson
T. W. Bratten
A. J. Catchot
H. A. Gerst

R. C. Young, Vice Chairman
F. H. Graham
B. W. Guppy
W. J. O'Brien

Committee

Your committee was instructed to report on ocean, lake and river docks, including docks handling ore and coal as well as those handling ordinary package freight to and from boats. The committee is not able to present any figures as to the value or extent of this class of property belonging to the railroads of the country, but it is unquestionably of tremendous amount and importance.

The subject of the maintenance of timber docks is a very pertinent one to the owners of the railroads at this time, owing primarily to the recently greatly enhanced value of timber, the difficulty of securing it and the very high cost and inefficiency of the labor used in applying it. The roads are now back in the hands of their owners, somewhat the worse for wear, but back nevertheless. However, they are not the same roads in many respects that they were when taken under federal control, as maintenance officers are rapidly realizing. Numerous changes in practice were made which are adding greatly to the difficulty of conducting maintenance work. Typical of these are the introduction of the eight-hour day with time and one-half beyond that period, the adoption of uniform working conditions, the almost universal organization of employees, and numerous other developments, none of which were designed to increase the efficiency with which work is conducted. The result is that the maintenance officer now finds he is confronted with the work of overcoming the deterioration of the past two or three years, with greatly increased costs of labor and material, with a more or less shortened organization and bound by seniority rules and regulations so numerous as seriously to limit his ability to handle his work with any degree of efficiency. More serious than any other development is the change in the attitude of labor. Not only is the morale lower than in previous periods, but the general attitude of the men has changed. The natural result of such a transition is a greatly decreased output of work per man-hour which serves still further to increase greatly the unit cost of the work beyond that brought about by the higher wage rate. The maintenance officer is confronted with a problem of Herculean proportions, the public rightfully demands that the roads be properly maintained, the owners also expect that this shall be done economically. The manner in which this can be done is a problem demanding the most serious consideration and the freest discussion is invited by the committee.

Inspection

Frequent inspections should be made in order to obtain the longest use of the timber without permitting the structures to become unsafe for use. The men who make the inspections should be men of wide experience and sound judgment, for upon their decisions rests the responsibility for the expenditure of large sums of money. Quite often the difference between safely-deferred repairs or immediate repairs, will be the difference between a reasonable return on the capital represented by the value of the structure and no return at all. On the other hand it may be a matter of economy to overhaul the dock at

regular intervals and put it in condition at such times to last the period before the next regular time for repairs. It would seem to be the part of good practice, on docks which are in constant operation, to endeavor to obtain all the life possible from all parts of the dock by close inspection and the employment of small crews continuously. In docks of seasonal use, like the great ore and coal docks of the upper lakes, repairs are ordinarily made during the winter to carry them through the next shipping season, and consideration cannot always be given to securing all the life of the timber which would become worn out before the next regular time of repairing. On docks of this sort large repairs can usually be deferred until winter with great advantage. No fixed rule can be made however, and the owners of the railroads must look to the men who have the responsibility of ordering repairs, to obtain as nearly as possible the full life of the timber. These results can only be obtained by careful inspection made at frequent intervals, and too much stress cannot be placed upon the employment of only competent men for this responsible work.

Time of Repairing Docks

The time for repairing a dock is more or less dependent upon the character of the business which is handled over it, and the part of the country in which the dock is situated. Its operation may be continuous, as in the case of ocean docks, or it may be seasonal as in the case of docks located on the Great Lakes or northern rivers which are ice bound during the winter months. Maintenance of docks which are in continuous operation is ordinarily more difficult and more expensive than of docks which are in seasonal operation only. In the first case, the dock must be kept in such condition as to not unduly interrupt the regularity of its operation, resulting in delays in the work of repairing it and often requiring the shifting of repair crews, while in the latter case, docks which are of seasonal use can be abandoned entirely to repair crews and the work handled without interruption. This is particularly true of the ore docks located on the upper lakes where the traffic is so great during the season of navigation that only emergency repairs can be made when the docks are in operation. It is the custom there to thoroughly overhaul them during the winter and put them in shape for an entire season's business. There can, however, be no set time as each class of dock is a problem by itself and the time for repairing it calls for the exercise of rare good judgment by the maintenance officials in charge, taking account of the labor and material situation, as well as traffic and other matters affected by it. It can be stated though that, other conditions being equal, summer work will be found to be less expensive than winter work, especially in the more northerly latitudes of this country.

Timber for Repairs

Consideration should always be given to the use of timber for repairs which grows contiguous to the railroad; even though the timber may not have the lasting qualities of that used in the original construction; provided it will last the remaining life of the dock. This is good business for the railroad, aside from the matter of maintenance. It should be the aim, so far as possible, in making repairs, to maintain all parts of the structure so that they will approach the state of obsolescence together. This can often be accomplished by taking material replaced at points subjected to very hard wear and using it in other places where the service is not so severe. Long piling in deep water which has become broken or decayed at the top, but which is sound under water, can often be pulled, cut into shorter lengths and re-driven in more shallow water. Decking in driveways, which has become worn and unsafe for heavy loads, can, when replaced by new material, be used in other places less exposed to wear. Timbers which have become decayed at the ends can be shortened into sound lengths and re-used. Instances have been known in the last two or three years in

which timber, taken from obsolete docks, has sold for more money than it cost originally when framed and placed in the structure. It is well to maintain sizable stocks of timber taken from dismantled structures for use in repair work of like structures. All decayed ends of such timber should be cut off and the sound timber piled neatly according to sizes. It is very convenient to have the lengths of the timber marked on the ends of the pieces so that the required lengths can be picked out readily.

Equipment

On docks of any considerable size, some equipment is necessary to make emergency repairs. Although large general repairs are frequently let out to a contractor who furnishes his own crews and equipment, there are many accidents on a busy dock that can not await the delay of securing a contractor to do the work. Depending upon the character and extent of the dock, this equipment may consist of cranes, derricks, pile drivers, etc., mounted on trucks or skids for land work and on scows for work around the water fronts of the dock. Floating drivers and derricks should be equipped with pumps, hose and jet for use in driving and pulling piles. A very good arrangement is to use a long scow, with pile driving leads on one end and a stiff-leg derrick on the other end, both operating from a hoisting engine placed at the center of the scow on a reversible platform or circular track, so that the engine can be faced in either direction to operate either the pile driver or the derrick as the case may be. A swinging engine may be placed upon the derrick end of the scow to be used in swinging the derrick boom. Such a scow should be about 32 ft. by 100 ft. in size and 5 or 6 ft. in depth. This will handle pile driving leads 60 ft. long and a 10-ton derrick with a 60 ft. boom. The great advantage of this outfit is that a small number of men will operate it and it is quickly adaptable to either pile driving or derrick work. If a three-drum engine is used and a clamshell bucket is provided, small shoals can be dredged and at times save the use of an expensive dredging machine. The tools required with an outfit of this sort include axes, saws, chisels, augers, jacks, blocks and tackle, wrenches, etc.

Owing to the members of the committee being so widely separated, and the impossibility of getting them together for a general study of the subject, special types of docks were assigned to each individual for a special investigation and report. Following this general opening of the subject by the chairman, these special reports have been prepared as follows:—

1. Maintenance of Timber Ore Docks—Great Lakes
   By R. C. Young, chief engineer, L. S. & I. Ry.
   By L. J. Anderson, supervisor of bridges and buildings, C. & N. W. Ry.
2. Maintenance of Timber Coal Docks—Great Lakes
   By F. N. Graham, assistant engineer, D. M. & N. Ry.
3. Maintenance of Timber Docks—Pacific Coast
   By H. A. Gerst, assistant bridge engineer, G. N. Ry.
   By T. W. Bratten, supervisor of bridges and buildings, S. P. Lines.
4. Maintenance of Salt Water Docks—Atlantic Coast
   By B. W. Guppy, engineer of structures, B. &. M. R. R.
5. Maintenance of Timber Merchandise Docks—Great Lakes
   By W. J. O'Brien, district carpenter, C. M. & St. P. Ry.
6. Maintenance of Timber Docks—Gulf Coast
   By A. J. Catchot, supervisor of bridges and buildings, L. & N. Ry.

TIMBER ORE DOCKS

By R. C. Young
Chief Engineer, Lake Superior & Ishpeming Ry., Marquette, Michigan

Previous to 1857 docks for loading iron ore into vessels were built the same as other docks which are used for handling coal, lumber, etc.

In that year the Lake Superior Iron Company, which is now a part of the United States Steel Corporation, built a timber ore dock at Marquette, Michigan, 25 ft. high above the water and containing 75 pockets; the ore was loaded by gravity from these pockets into sailing vessels of from 200 to 300 tons capacity which were then used to transport the ore. These docks have developed with the iron ore business until now the highest timber dock is 78 ft. above the water and the longest one is 2,304 ft. long and contains 384 pockets with a storage capacity of nearly 80,000 tons of ore. The maximum vessel load is about 12,000 tons.

The question of the maintenance of timber ore docks is one which will probably become less pertinent as time goes by and will probably be confined to the wooden ore docks now in existence. The committee is of the opinion that owing to the rapidly increasing cost of timber and labor the cost of construction and maintenance of such ore docks will soon become prohibitive as compared with those of more permanent nature.

In 1910 the Lake Superior & Ishpeming Ry. Co. was preparing to build a new ore dock and made estimates of the cost of construction and of maintenance of the different classes of ore docks covering a period of 30 years, assuming that the docks of permanent construction might be retired by reason of obsolescence at the end of that period This assumption, however, will probably not prove true. To arrive at a comparison it was assumed that a second timber dock on a new foundation would be necessary about the fifteenth year to insure always having a dock ready for operation.. This would give a life of about 16 years each to the wooden docks. The comparison of first cost is as follows:

Two Timber Docks	Concrete	Steel
100 per cent	70 per cent	76 per cent

Estimated cost of construction, repairs, interest, insurance and taxes over a term of 30 years is as follows:

100 per cent	56 per cent	62 per cent

It is probable that because the increases in material and labor have been so much greater than was estimated in 1910 the comparison would now be even more favorable to the permanent structure. At any rate these figures are significant enough to bear out the prediction that there will be no more timber ore docks built.

However, we still have the problem of maintaining the ones now in existence.

The maintenance of timber iron ore docks presents different problems from that of other timber structures, and depends to a great extent upon the tonnage passing through them. Companies having several docks have been able to extend their life by using the older ones for storage, but companies depending upon one dock for their entire ore business are obliged to keep it in a better state of repair to avoid the possibility of interruption to the business. The dropping of the ore from cars into the pockets causes an impact that tends to break the pocket bottoms, fronts and doors. The wearing action caused by running the ore from the pockets through the steel chutes into the vessels causes the pocket plank and steel chute lining to wear out very rapidly. Very often in the hard ore section this plank and steel chute lining will not last longer than one season. In the soft ore section they often last 4 or 5 years, depending on the tonnage passing through them. The maintenance of the deck does not present any special features but is similar to the maintenance of any platform or dock deck.

On account of their being in constant use in the summer time all repairs to the pockets, deck and chutes must be done in the winter. The work of relining the chutes can be done economically by using an ordinary derrick upon which has been installed a large capacity locomotive air pump and reservoir. The old linings can be cut out and the new ones put in place, drilled and riveted by means of air tools. A part

of the larger and heavier chutes are built without linings in such a way that when the bottoms are worn out they can be taken out and new sheets inserted in the place of the worn ones. In 1917, 1918 and 1919 some experimental repairs were made by the Great Northern Railroad by means of the oxy-acetylene method, the results of which are given in the following letter—

"Your letter of March 23rd addressed to Mr. Wollan, in regard to success of repairing ore spouts with the acetylene-oxygen welding system, has been referred to me. I am giving you herein the result of our experiment. During the winter of 1917 we found four chutes which were badly damaged and which required repairs. The chutes were removed and sent to our Superior shops where they were repaired by patching with the welding system. After the chutes had gone through a season's run, we made an inspection of them and found that the repairs which had been made in this manner were satisfactory and the chutes were still in good condition.

"It was then decided that inasmuch as this system was a success, the work could be done more economically by leaving the chutes in place on the dock rather than removing and forwarding to the shops and after being repaired, returned and again put in place on the docks. In the winter of 1918 and 1919, with an oxygen-acetylene welding outfit on the docks, furnished by us to Contractors Peppard & Fulton who did the repair work that year, they repaired an average of five chutes per day, which included the cutting out of the defects and welding in the new plates. The patching plates were delivered to the docks cut to various sizes, and the average consumption of gases for so repairing five chutes was one tank of acetylene and two and one-half tanks of oxygen.

"During the winter of 1919 and 1920 repairs were made in a similar manner but due to the severe cold weather while this work was in progress, and the apparent scarcity of gas, we averaged only three chutes per day. However, the repairs made during this time were more extensive than previous, the patching plates being larger and the plates were also cut to size on the job, which work had been previously done at the shops.

"The plates for patching small holes were cut triangular in shape and one point placed against the run of ore.

"The following is the amount of labor and material, together with the cost of same, for making repairs to five chutes under favorable weather conditions and with sufficient material on hand:

285 cu. ft. of acetylene gas at 0.02½ per ft., ...	$ 7.12
550 cu. ft. of oxygen gas at 0.01¾ per ft., ...	9.62
10 lbs. 3/16 in. ox-weld rods at 0.14 per lb., ...	1.40
150 lbs. ¼ in. thick sheet steel at 3.40 per cwt., ...	5.10
Welder 10 hrs. at 0.80 per hr., ...	8.00
Helper 10 hrs. at 0.60 per hr., ...	6.00
	$37.24

"This will make an average cost per chute of $7.46, which I consider is very economical and efficient. If extensive repairs are contemplated, the cost could be reduced materially by placing two welding crews on the job, one to do the cutting and the other to do the welding.

"Yours truly,
"H. J. Seyton,
"District Engineer."

It has been found economical to protect the stringers by spiking old chute linings on the sides to prevent them from being damaged by falling ore, otherwise the maintenance of this part of the structure does not present any special problem.

The Lake Superior & Ishpeming Ry. Co.'s ore dock was finished for use in the latter part of 1896. The cost, including the approach and

dredging, was about $330,000. The cost of repairs to ore dock and approach, not including dredging, commencing in the year 1900 is as follows:

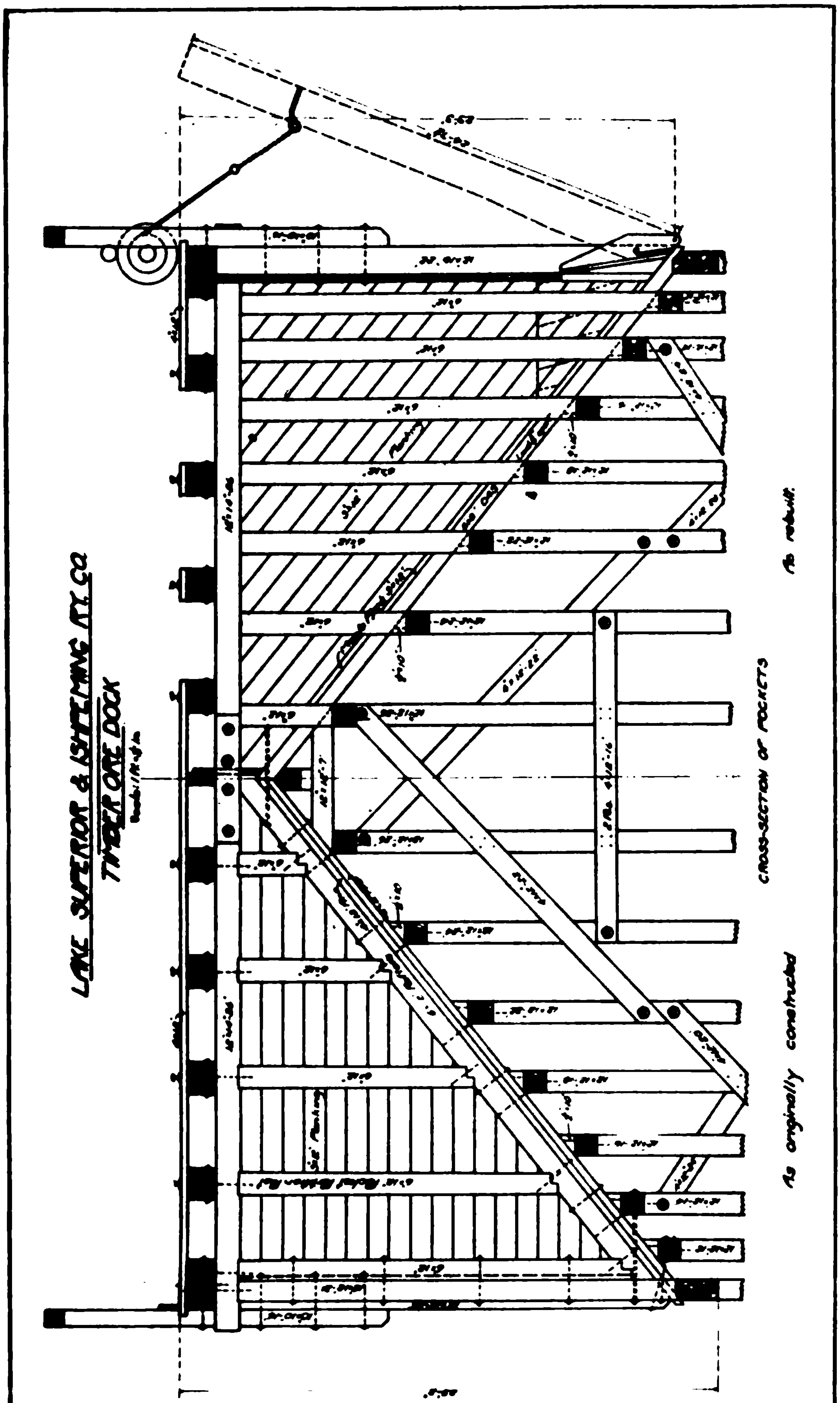
Year	Labor	Material	Total
1900	$ 866	$ 425	$ 1,291
1901	1,200	2,400	3,600
1902	2,408	4,897	7,305
1903	1,789	2,972	4,761
1904	2,433	8,011	10,444
1905	608	4,338	4,946
1906	22,269	31,559	53,828
1907	26,443	6,230	32,673
1908	4,688	6,859	11,547
1909	5,321	7,103	12,424
1910	6,240	4,278	10,518
1911	4,505	2,520	7,025
1912	1,553	902	2,455
	$80,323	$82,494	$162,817

The repairs during 1897, 1898 and 1899 are not shown but were probably very light.

The heavy repairs in 1904 were caused by faulty design in the approach which did not have sufficient bracing. Also the Norway piles under the bents were allowed to project above the ground in some cases as much as ten feet. The cost of replacing these piles with fir timber and adding the omitted bracing explains the extraordinary costs for that year. In 1906 and 1907 the top of the dock above the pocket bottoms was entirely rebuilt, one half each year. This was made necessary on account of faulty design. It will be noted that the bottom of the pockets are covered with a double thickness of 4 in. by 12 in. plank. This supports the 6 in. by 12 in. rafter, which in turn carries the pocket partition posts. It will be seen that this form of construction closes the bottom of the pocket partition, making a water pocket which causes the bottom of the pocket partition post to decay. These posts carry the whole load of the train. This load causes the cap to sag and break as soon as decay starts. It is inaccessible and very difficult to repair, therefore it has been the experience of our company and other railway companies having docks of similar design that it is cheaper to renew the upper work after the ninth or tenth year than to keep up the repairs.

In renewing this upper work the plan of construction was changed. The location of the pocket partition posts was changed and the post carried down to the top of the longitudinal girt over the post below. The rafter was omitted, leaving the partition open to admit the air; the double 4 in. by 12 in. planks in pocket bottoms were replaced with fir 6 in. by 8 in., S4S and laid ⅛ in. apart, so that the air could circulate to the bottom of the maple wearing plank and keep it dry. The pocket partition plank was laid parallel to the pocket bottom instead of horizontal so that the wear from the running of the ore will be lengthwise of the grain of the wood and so that it will only wear on the bottom planks of the pocket instead of wearing the ends off of all of them. The lower part of the dock is sheltered from the weather and has a longer life.

The next thing that gave serious trouble was the fender or vessel wale. The Norway piles rotted off about 2 ft. above the water and were replaced by fir timber. This made a joint where the timber connected with the pile. To strengthen these some 1¼ in. old steel cable was procured from the mines and stretched across from fender to fender every 36 ft. or where the cast iron vessel cleats were located. The regular pile heads were replaced when rotten with cast iron vessel cleats. These cables were tightened with a turnbuckle in the center. It was later found necessary to put some braces diagonally from the top of the


LAKE SUPERIOR & ISHPEMING RY. CO.
TIMBER ORE DOCK
CROSS-SECTION OF POCKETS
As originally constructed
As rebuilt

fender, notching them into the first four posts and bolting them to the sill under the fifth post; also a horizontal brace from the bottom of the fender, notching it into and bolting it to the first two posts. This procedure corrected the fender difficulty.

The next serious difficulty was on account of decay at the ends of the longitudinal diagonal bracing and the constant shock, caused by setting the emergency air brakes in spotting cars over the pockets. The bents at the outer end of the dock were pushed out of plumb, leaning toward the lake and those on the shore end were out of plumb leaning toward the shore. The Lake Superior & Ishpeming Ry. dock went 19 in. out of plumb in two weeks. These bents were braced up with long stiff timbers which also carried part of the load so they could not get any worse. The bottom part of the structure did not give very much trouble. Some of the extreme outside posts were renewed where they were subjected to the weather and at the last the 14 in. by 14 in. sills on the piles began to decay on top and split open. These carry such a heavy load it was impracticable to renew them so they were strengthened by bolting a 4 in. by 12 in. plank on each side to hold them together. The dock was last used for shipping ore in 1913.

The dock proper consisted of 200 pockets; it was 45 ft. wide, 53½ ft. high and 1,200 ft. long and contained approximately 4,200,000 ft. B. M. of timber, of which it was estimated that 2,471,000 ft. would be usable after dismantling. The approach was estimated to contain approximately 1,366,000 ft. of usable timber.

After about 18 per cent of the dock proper had been dismantled it was decided to build a saw mill and convert this usable timber into lumber. The cost of taking down this 18 per cent, cleaning the timber and taking out the bolts and spikes was about $7.65 per thousand feet B. M. of usable timber which includes the cost of removing the timber which had no value.

The saw mill was built in 1916 at a total cost of $2,690. The estimated net salvage from the dock after deducting all costs of dismantling, cleaning, sawing, etc., was about $50,000.

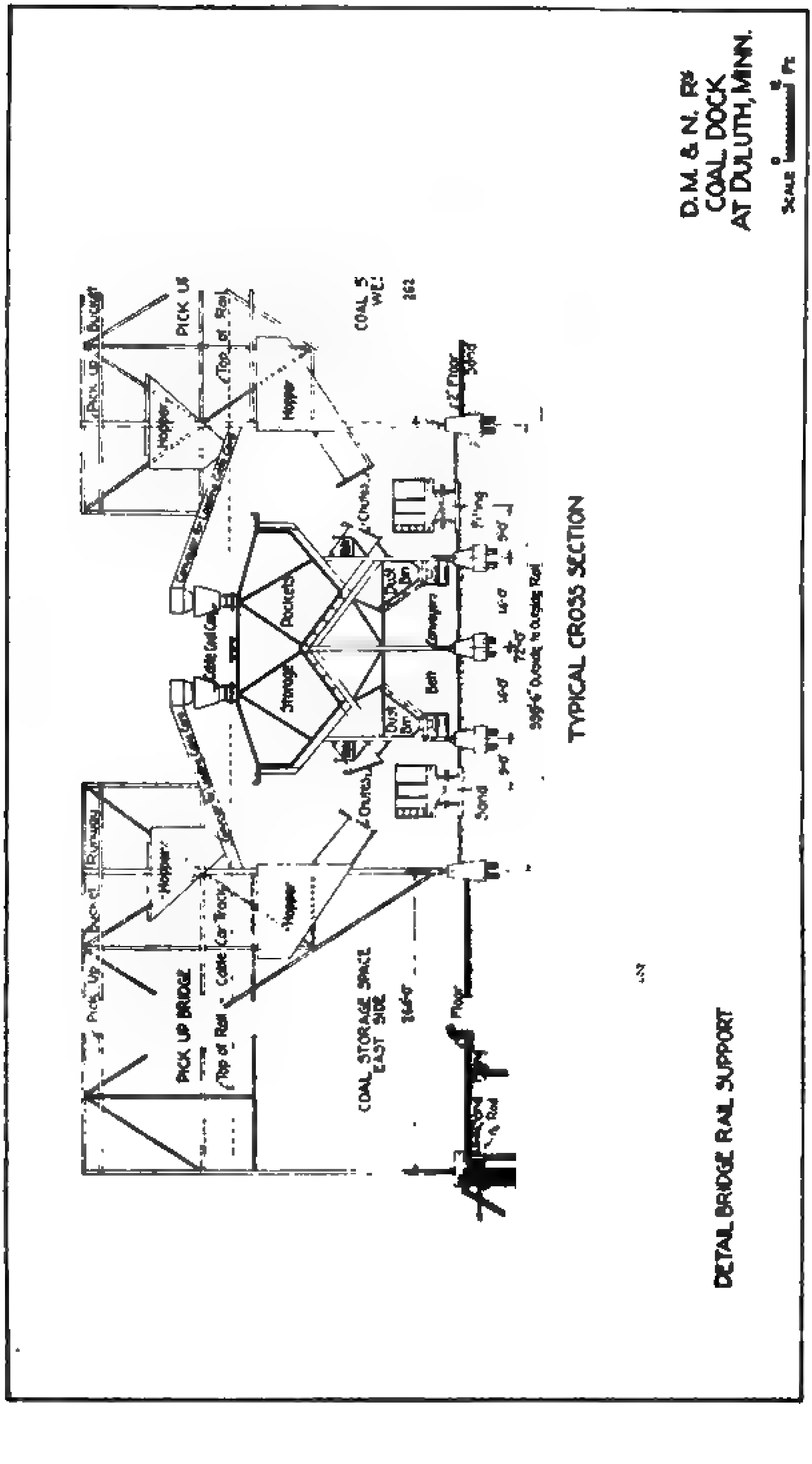
The timber in the sub-structure under the center of the dock was in excellent state of preservation. Some of it being clear white pine, it was possible to get pattern lumber and other high priced material from it. A detailed report of this operation is published in the report of the Committee on Conservation of Natural Resources of the American Railway Engineering Association, on March 16, 1920.

TIMBER ORE DOCKS

By L. J. Anderson

Supervisor of Bridges and Buildings, Chicago and Northwestern Railway, Escanaba, Michigan

Our largest size docks are 52 ft. wide, and 70 ft. high above water line with the chute hinge point 37 ft., 9 in. above water line. These docks are built on pile foundation in bents of 6-ft. centers. For the first 6 or 7 years after a dock is constructed, there is not much maintenance. The first heavy maintenance will be in renewing bottom linings and some repairs to the fronts. These bottom linings consist of 3 in. maple planks. In 9 or 10 yrs. the next heavy repairs will be the renewing of the partition linings and many deck plank. During these 9 or 10 yrs. there will be more or less minor repairs in the nature of renewing broken or decayed planks. In about 15 yrs. it will be necessary to renew the "A" deck or that part of the dock above the posts, especially if no treated timber has been used in the construction. In the building of our docks we now treat the timbers in the plates, rafters and partition posts, as it is expensive and difficult to renew those timbers; this reduces the maintenance materially and increases the life of these timbers about 100 per cent. After the "A" deck is renewed, the dock is good


D.M. & N. Ry
COAL DOCK
AT DULUTH, MINN.
TYPICAL CROSS SECTION
DETAIL BRIDGE RAIL SUPPORT
PICK UP BRIDGE
COAL STORAGE SPACE EAST SIDE
Hopper
Storage
Pockets
Bin

again for 10 or 15 yrs., with necessary repairs as before to the wearing parts of pocket linings and deck planking.

In some of the old docks which have not been constructed of treated timber and which have been maintained by not renewing the entire "A" deck at one time, it has proved very expensive to renew the plates and door sills. That part of the dock below the "A" frame does not require much repairs except the sills or pile caps and fenders. If the piles are cut off one foot or more above water level, then the sills or pile caps will have to be renewed in about 15 yrs. Fenders also have to be renewed in about 15 yrs.

Chutes begin to show holes and need attention and heavy repairs after 7 or 8 yrs. use. Chutes on old and smaller docks are made up in sections of ¼ in. metal with inside linings fastened with bolts which lining protects the chutes proper. It is then only necessary to replace or repair the lining, which is done at a cost of labor of about $2 per plate.

The new and larger docks have a larger chute which extends over the entire width of the pocket, and which is built up in sections of one thickness of ¼ in. plate. Repairs to these plates are made by cutting out the rivets and replacing the worn out section. Such repairs are very expensive, the cost of labor being about $12 for each plate in 1920.

The work of maintaining docks is done during the winter months or during the season of closed navigation, for the docks must be in readiness at the opening of navigation.

During the first 8 or 9 yrs. the cost of maintenance is not very heavy, but in the period when the dock is from 9 to 15 yrs. old the cost is heavy; for our larger docks, it will run from $20,000 to $40,000 per year. Labor costs in 1920 ranged from $30 to $35 per 1,000 ft. B. M. for pocket and dock work; from $40 to $45 per M. for sill and cap work and from $50 to $55 for plate and door-sill work.

TIMBER COAL DOCKS

By F. N. Graham

Assistant Engineer Duluth, Missabe & Northern Railway, Duluth, Minnesota

Coal docks at the head of the Great Lakes receive their supply of coal from the lower lake ports by boats, from which unloading towers transfer it either to the dock storage area or directly into railroad cars. Distribution from these docks to the northwest territory is made by rail. The maintenance of these docks requires careful, periodical inspection of dock fronts, storage floor and bridge rail supports.

The typical construction of docks in this locality includes a row of water tight sheeting, enclosing three water front sides of the dock area, held in line by rods fastened to anchor piles and logs some distance from the face of the dock. This sheeting is protected from the impact of boats by a timber fender consisting of wale timbers of oak or fir framed and bolted to piles driven uniformly along the dock front adjacent to the sheeting. These wale timbers show much wear from boat movements, necessitating frequent inspection to determine the maintenance necessary before the usual renewal period. Much extra expense is incurred if a split fender timber is left in place, allowing shearing of bolts and possibly crippling fender piles. Fender renewals can be made economically from the ice in winter, allowing recovery of all timber removed, and eliminating delay to boats.

Pile clusters at the front corners of the docks are badly damaged and occasionally broken off entirely by boats during stormy weather. The timber bridge rail construction of the unloading bridges consists of a two pile bent, driven just inside the sheet piling, capped to support

the bridge rail stringer. Keeping the proper alinement and surface of this bearing increases the efficiency of the unloading rigs.

On docks of the Northwestern Fuel Company in this vicinity, this construction from the water line up is required to be thoroughly treated with Carbolineum. The only part exposed to the weather is the stringer. Upon the sand filling a 2 in. tamarack or maple plank floor is laid with mudsills of the same thickness generally. This plank is laid at 45 deg. or 90 deg. with the direction of the bridge rails and covers the width between them. Much damage is done to this floor by the pick-up buckets being dropped suddenly when cleaning up the dock. Spontaneous fires cause renewals of floor sections. On one of the commercial coal docks at Duluth, one of these fires burned for months, doing much damage to the floor.

Parts of the floor which are never covered with coal and are continually exposed to the weather deteriorate fast, losing their usefulness without patching up. At the Duluth, Missabe & Northern Railway dock at Duluth, Minn., the unloading rigs are at the front of the dock with storage areas on either side of the center line of the dock, served by pick-up bridges and storage pockets along the center. On the east half of the dock, two pick-up bridges move along a timber bridge rail support at their east end, consisting of a 3-pile double capped bent on 6 ft. centers. Double capping was resorted to when the original piling showed decay around the cutoff and an additional pile was driven. This year this construction is being reinforced by driving a 2-pile bent midway of the present bents. Eventually all piles of bents will become part of a concrete foundation when the timber needs renewal. The total area, over 900,000 ft. of plank on this dock is of 2 in. tamarack on 4 in. by 6 in. mudsills. The plank on the east half of the dock will be renewed after 13 years of service.

High prices of timber will cause the revision of the construction of many docks to use concrete and eliminate much of the maintenance.

TIMBER DOCKS ON THE PACIFIC COAST

By H. A. Gerst

Assistant Bridge Engineer, Great Northern Railway, St. Paul, Minnesota

Plans of Great Northern Railway's Docks at Smith's Cove, Seattle, are submitted herewith as typical of a large railway dock situated along a body of tide- and salt water. These docks are on Elliott's Bay, an inlet of Puget Sound. A slip 196 ft. wide adjoins the main dock on the west. The depth of water in the slip has varied between 22 and 31 ft., but a depth of 28 to 31 ft. has been dredged out during the past few years to insure heavily loaded cargo vessels clearing the bottom of the waterway safely.

The maintenance of this dock brings up the question of the use of creosoted piles which subject should be of interest to members of this Association. Creosoting plants in this district are located at Seattle, Portland and Vancouver, B. C. Fir piling, either air or steam seasoned, are accepted for creosoting. A treatment of 16 lbs. per cu. ft. gives satisfactory results and a life of from 10 to 20 years may be expected in these teredo-infested waters, provided piles are not injured by mechanical wear due to rubbing of the sides of boats. It may be said, however, that the chafing of piles from the sides of vessels is generally above the line where teredo are active. Treatment of creosote oil is the best practical method for protecting timber from attacks by marine borers.

The cost of the creosoted piles in place for fenders is from two to three times the cost of untreated or bark piles. The average life of untreated fender piles at Seattle and Everett docks is only from 18 mo. to 2 yrs. It is readily apparent that the creosoted pile is the more eco-

nomical. It should also be considered that frequent replacement of untreated piles interferes with the shipping at a busy dock.

With reference to the maintenance of parts underneath docks it has been found that teredo eat away the brush bulkheading, allowing the filling material to slip out. This is rectified to some extent by placing coarser filling and rip-rapping. Subsequently additional dredging is resorted to in order to remove surplus filling which has slid into the slip. Where piling has rotted and been eaten by teredo, temporary timber blocking has been used under old dock structures to make them safe until such time as a complete renewal is advisable.

Regarding timber docks (or generally any dock not of fireproof construction), it is especially urged that a sufficient number of fire walls and curtain walls be provided for fire protection. Fire walls should extend from low water line to several feet above the roof and be made of interlocking hollow tile. Curtain walls serve to check the draft in case of fire. It is recommended that the interior of dock buildings be painted with cold water paint or a whitewash which presents a sanitary appearance, aids its lighting and acts as a fire retardent.

TIMBER DOCKS ON THE PACIFIC COAST

By T. W. Bratten

Supervisor of Bridges and Buildings, Southern Pacific Lines, Oakland Pier, California

Creosoted piling has been used exclusively in the construction of docks and wharves on the Pacific Coast for the last 20 years and for practically all docks constructed in the 10-year period preceding that. An untreated pile will only last from one to two years until it is eaten off by the marine borers. Although in some cases, when piles have been split or damaged in driving, the marine borers have entered and done some damage to these piles, but generally speaking they have given very good satisfaction. One of the wharves owned by our company, known as the Oakland Long Wharf, was removed during 1919. The creosoted piles in this wharf were all pulled out and about 90 per cent of them were found in good condition and were used over again, some of them by our company, the others by outside contractors. A portion of these piles were in use in this dock for over 30 years and the balance for over 20 years before they were pulled. It is interesting to know that the creosoted piles placed in this dock 30 years ago cost 30 ct. per lin. ft., and after being removed, those not used by our company, were sold for 40 ct. per lin. ft.

All our wharves are built of standard construction, consisting of creosoted pile bents on 10 ft. centers with 12 in. by 12 in. creosoted pine caps, 12 in. by 14 in. rough pine stringers, and 4 in. by 14 in. rough pine joists covered by 3 in. decking.

SALT WATER DOCKS

By B. W. Guppy

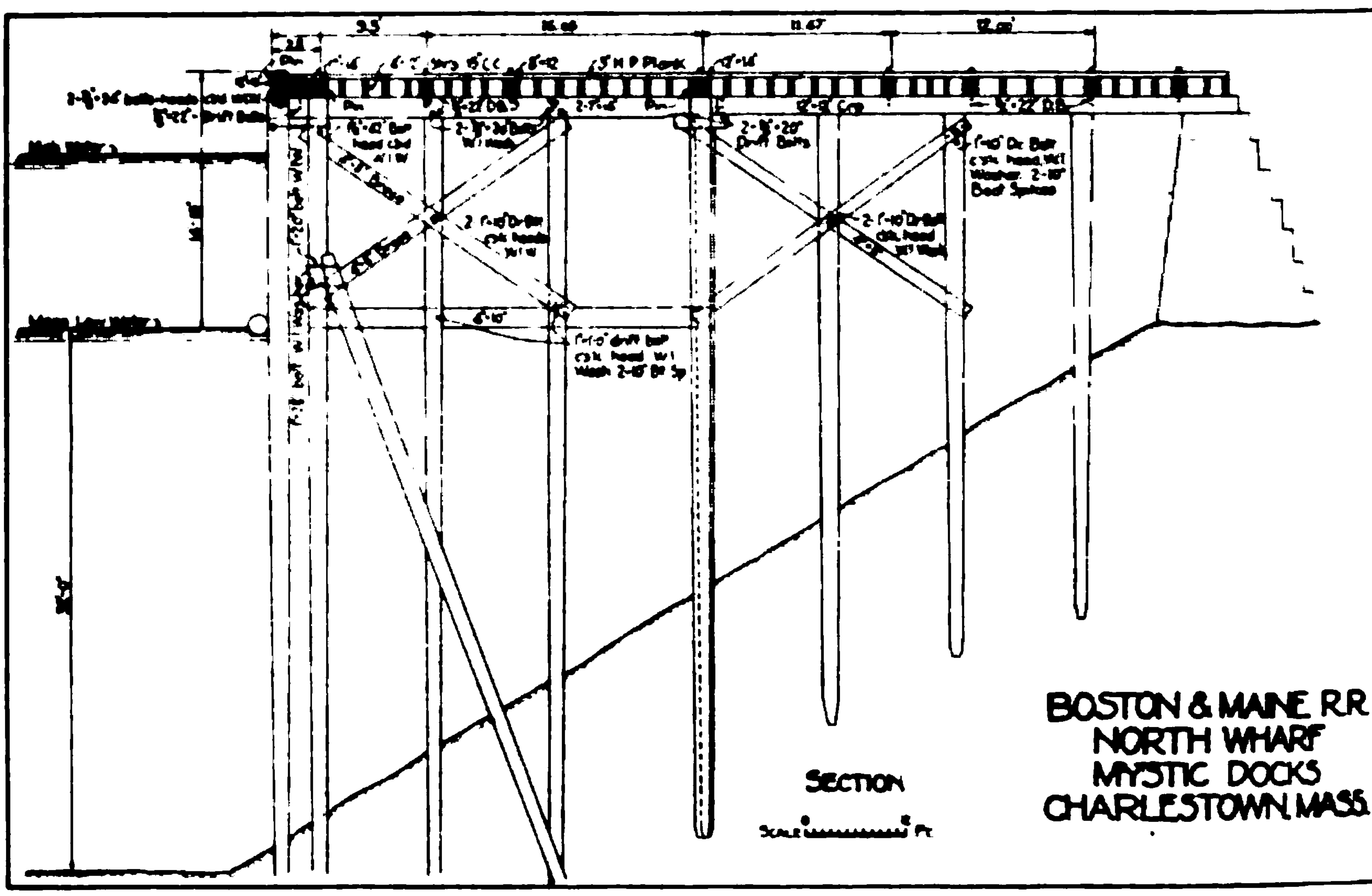
Engineer of Structures, Boston & Maine Railroad, Boston, Mass.

This report will be confined to docks north of Cape Cod in waters not infested by the teredo. Two general types of structures are used, the pile platform and the log crib. The former is generally used at the seaports between Boston, Mass., and Portland, Me., and the latter at points on the Maine coast east of Portland.

At the Boston Terminal of the Boston & Maine there are 2,829,000 sq. ft. of pile platforms along the waterfront of Boston Harbor and over the Charles and Mystic rivers, used as wharves and supports for freight

houses, station buildings, yards, driveways, and tracks, both main line and sidings. The area of pile wharves at other points is small by comparison. The platforms are built with white oak piles, and hard pine caps, stringers, ties, bracing, and planking. In some sections solid caps are used, in others, girder caps with and without riders. In some of the yards the piles are capped at mean high water and the area floored solid with timber and filled to grade with cinders or gravel. Driveways on these filled areas are paved with granite block.

As the various sections have been built or renewed at different times and are subject to varying usage, the maintenance of the platform is a continuous performance. Two inspectors cover the "Terminal Division." These inspectors are provided with tables showing maximum stresses and allowable depreciation, to be used as aids in determining the necessity for repairs. Bents, tracks and piles are numbered so



that points requiring repairs can be located accurately on the reports. At each inspection the inspector reports all timber requiring renewal within 12 months and the latest date by which each particular piece of work should be completed.

In general, repairs to any given section are made by "patching to carry" until the entire section is ripe for renewal. These running repairs consist in cutting off and splicing individual piles, framing on girders below pile tops and blocking between old and new caps, renewing an occasional stringer or weaving in additional stringers and renewing ties.

When a section is renewed, the poor piles are pulled and new ones driven and the dock renewed with new timber. The section is brought up to standard strength at this time. All of the old timber that can be salvaged is used for patching elsewhere.

In certain sections supporting storage tracks, the old piles have been cut off at low water and framed bents built on them to support the deck, making double deck bents. This method can be used only when the piles at the point of cut-off have sufficient area to get sufficient bearing on the sills of the framed bents. A rugged system of longitudinal bracing is necessary to keep bents from "knuckling" and there is some trouble from ice displacing this bracing in winter. But

little trouble is experienced from sea worms at the Boston Terminal, but farther east, as at Portsmouth, N. H., where the water is cleaner and saltier, about 40 per cent of pile renewals are due to damage caused by the limnoria. In localities where these worms are active piles are examined by a diver biennially.

Log cribs are used where native timber is plentiful and the bottom is too hard for piles to be driven. They are usually built of rough logs of hemlock, spruce, fir or pine. In one instance known to the writer square sawed timber was used, being cheaper than logs on account of the log scale in use in that particular locality. The bottom is leveled or stepped as conditions permit and a crib work of round logs or squared timber is made with openings or checks 6 or 8 ft. square. At convenient heights these checks are floored over and filled with rocks, all intersections of timbers are securely fastened with two ¾ in. by 18 in. drift bolts. If the wharf is not too large it is built up and sunk in one piece. If conditions will not permit this, it is built in sections, and sunk separately and fastened together. As the crib is built up and the bottom layer nears its foundation, it is carefully brought to line and enough ballast added to sink it over the bed so that the crib will fit the place prepared for it without distortion or undue strain. Occasionally 12 in. by 12 in. vertical sticks are placed in the corners of the crib, extending the full height to add stiffness to the structure.

As the tops of the crib wharves rot out they are renewed from the water line up. Eastport pier was built in 1898 and the top had to be rebuilt in 1919. The outer side is settling and rolling out below the water line, caused by marine worms destroying the front logs which are crushed by the weight above. Crib wharves in rivers are not attacked by marine worms if fresh water is present in any quantity.

Crib wharves are often floored over at about high water and several feet of gravel put on the floor to bring it up to grade.

(The writer is indebted to Walter H. Norris for information regarding crib wharves.)

TIMBER MERCHANDISE DOCKS

By W. J. O'Brien

District Carpenter, Chicago, Milwaukee & St. Paul Railway, Milwaukee, Wisconsin

Until recently all wharf and dock fronts were of timber and pile construction, consisting of a row of piling driven from three to four feet on centers, to the desired depth below dredging line along the front of the wharf or dock. One or two wale-streaks are placed horizontally on the outside of the front piling to equalize the pressure from docking boats and, as they are subjected to the principal wear, they should be of hard wood. Another row of piling known as anchor piling is driven from 12 to 20 ft. back of the front piling and parallel to it. Anchor rods are then placed from the wale-streak through a timber placed horizontally at the back of the anchor piling to hold the piles in position. Ground conditions sometimes necessitate the driving of a second row of piling about the same distance from the anchor piling and connected with tie rods. (See Fig. 1.)

Sheet piling consisting of two thicknesses of 3-in. or 4-in. plank, is driven to a depth below dredging line in the rear of the front wharf or dock, with strips placed horizontally between the front and sheet piling to hold it in place. This is done to allow filling and to make the dock front tight. In capping wharf fronts one or two pieces of 12 in. by 12 in. timber are used.

The lower wale and also the anchor timbers should be placed with the top about on water level. While this may increase the first cost of construction, it will perpetuate the life of the piling. Piling will decay

above water line in from 5 to 10 years, depending on the kind of piling used. In making repairs to wharves and docks where the piling is decayed above the water line, the piling is cut at the water line and cribbed up with 12 in. by 12 in. timber to the desired height. (See Figs.)

My experience in this class of wharves and docks has been confined to the inland wharves as constructed by the Chicago, Milwaukee and St.

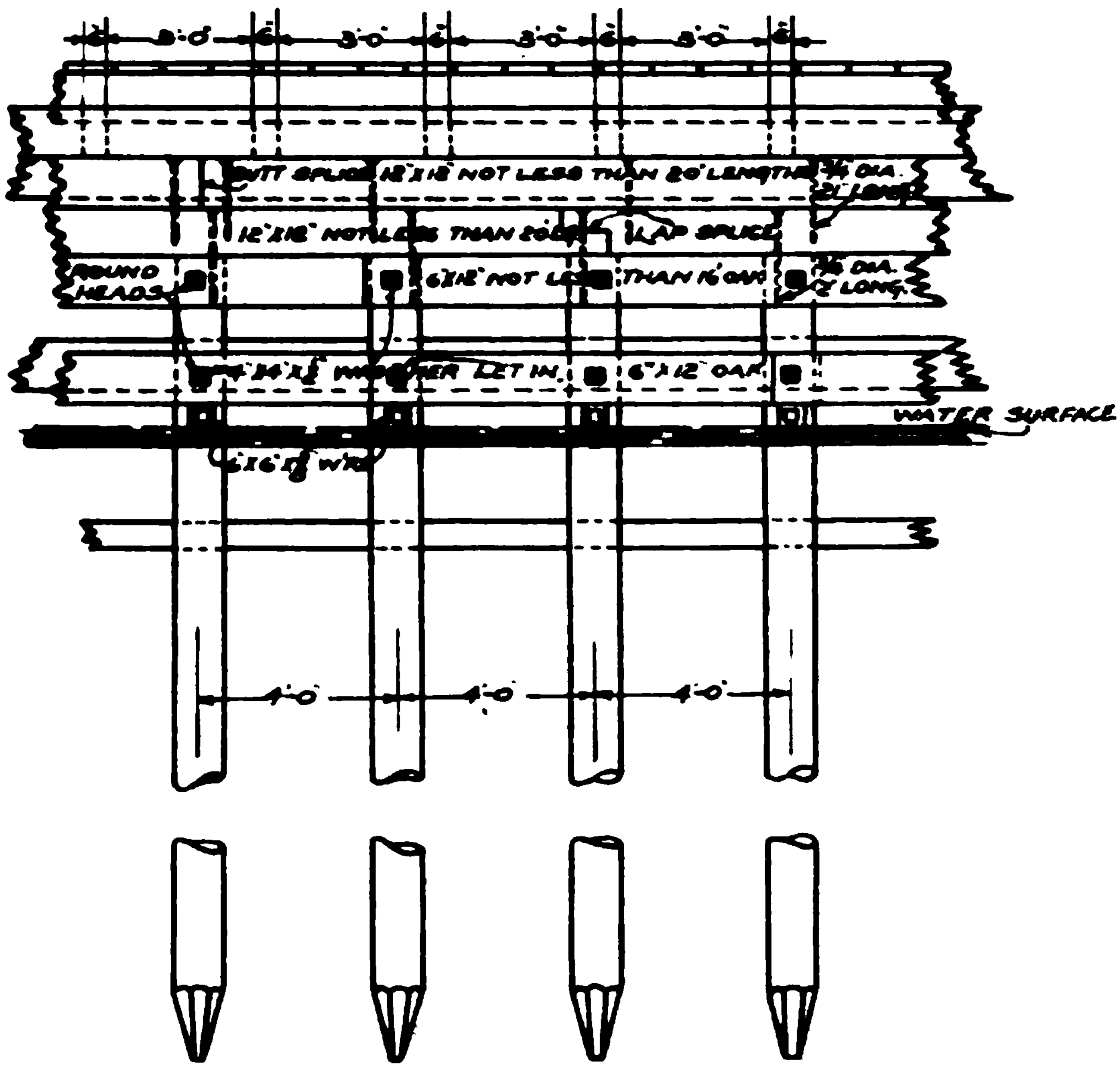


FIG. 1 DOUBLE CAP WHARF. C.M.&ST.P.RY

Paul Railway. At the time of construction of the present docks they cost approximately $25 per lin. ft. complete, but to construct them under the present conditions would cost from $75 to $100 per lin. ft., depending on the location and the kind of piling and timber used. In looking over the sketches it will be noted that the details of construction have been avoided as wharves or docks must be built to suit the occasion.

The following specifications are used for the construction, rebuilding and repairs of this class of wharves and docks:—

Piles are to be of sound, live timber; oak, tamarack or pine of proper lengths; 9 in. at the point and 14 in. at the top or butt end. Piles are to be driven full length, plumb and in true line and must be spaced not more than 3 ft. from centers.

Anchor piles are to be of suitable lengths; 9 in. at the point and 14 in. at the top or butt end. Anchor piles are to be of sound, live timber; oak, tamarack or pine, should be driven in a row and parallel to and not more than 20 ft. back of the dock piles and spaced not more than 6 ft. apart from centers and sawed off level 2 ft above the datum line. The piles must be in a true line and properly faced for the anchor sill.

A 6 in. by 12 in. white oak wale-streak should be fastened against the outside of the dock piles; the top of the wale-streak to be 4 in. above the top of such piles when cut. The piles must be faced to a line so as

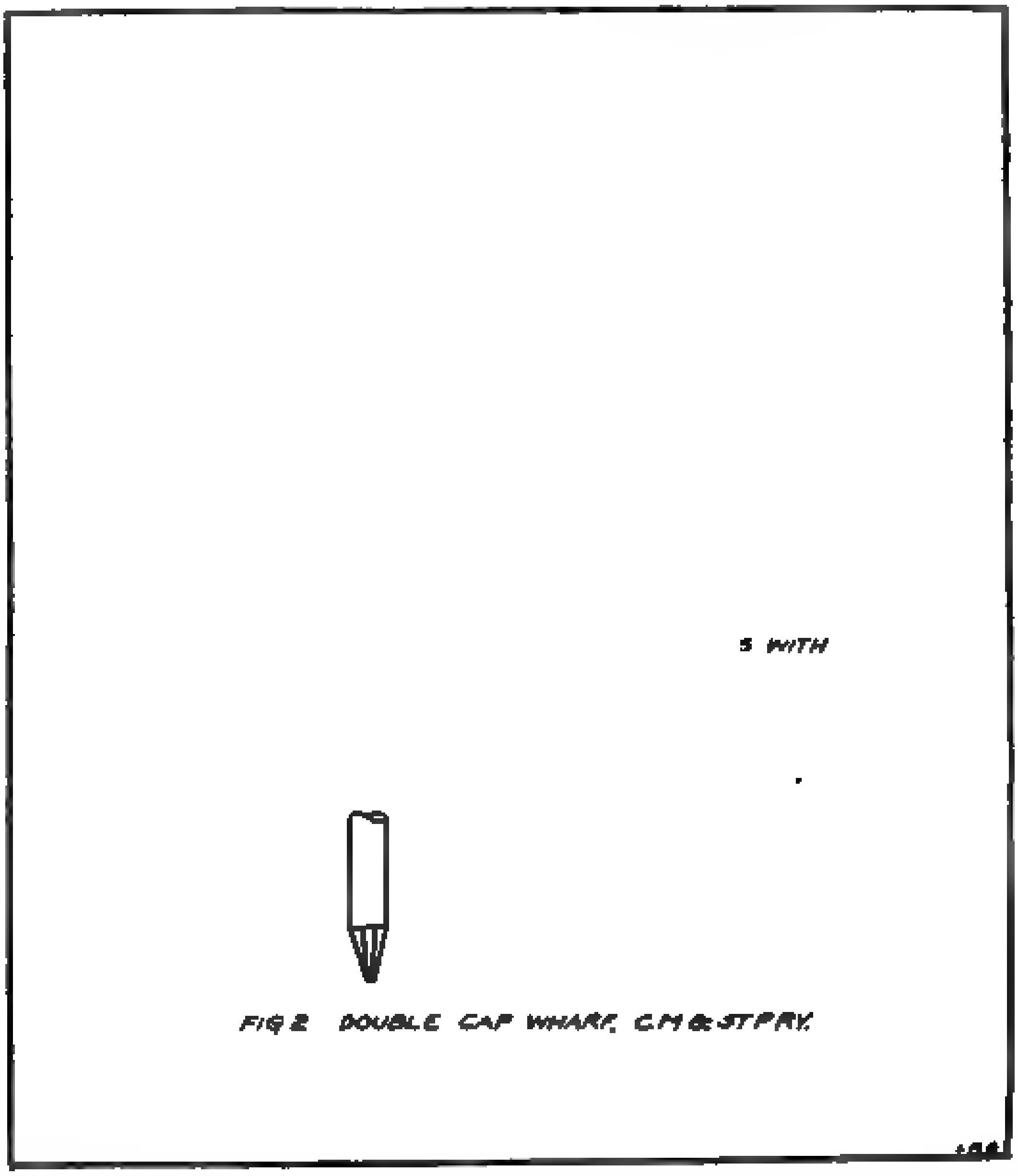
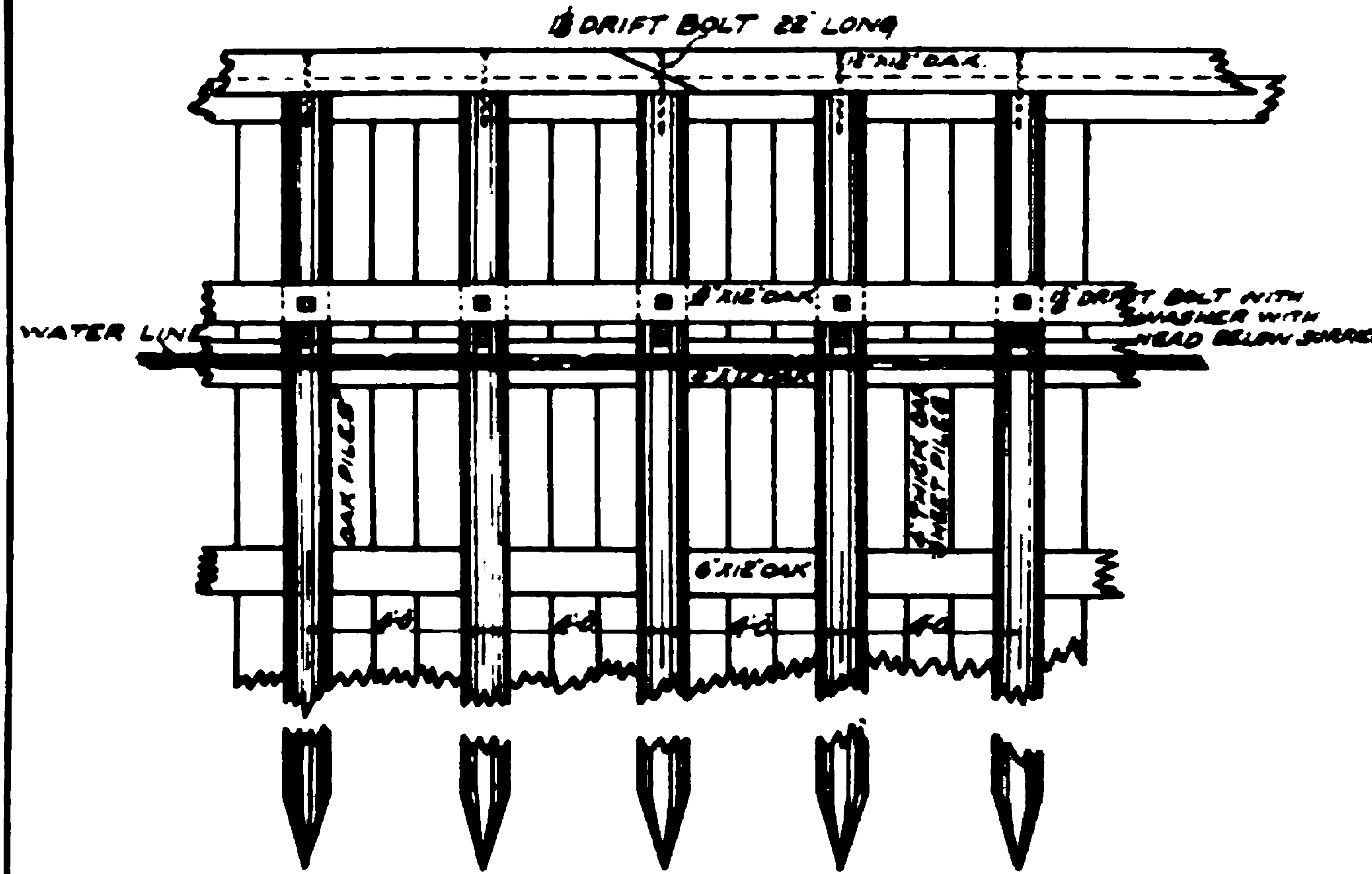


FIG 2 DOUBLE CAP WHARF C.M.&.ST.P.RY.

to afford a good bearing for the full width of the wale-streak. Splices in wale-streaks shall be made over a pile; each end to be secured to the pile by 1¼ in. screw bolts, countersunk. The wale-streak must be tied to the anchor sill or through each anchor pile by a wrought iron rod, 1¼ in diam., upset to 1⅜ in at the screw end of such length as may be necessary.

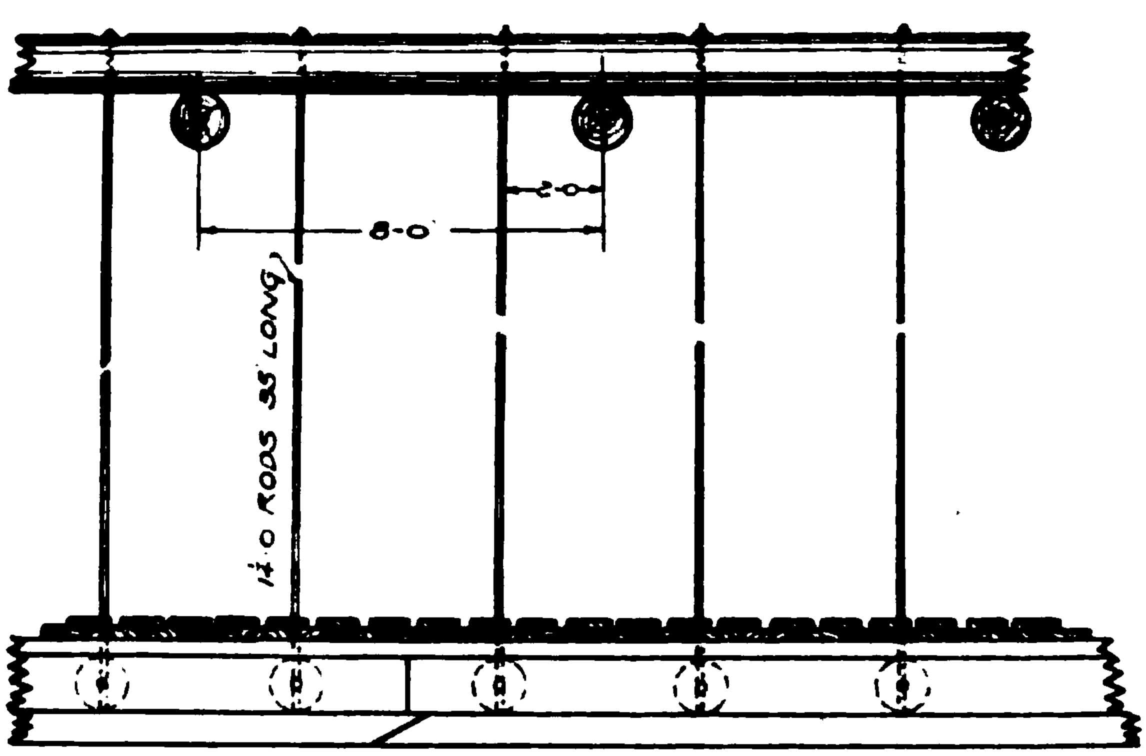
The tie rods shall be provided with nuts and washers at each end; those in front to be properly countersunk into the wale-streak. The tie rods must be spaced not more than 6 ft. apart; must be straight and properly tightened before they are covered or any filling is placed behind the dock.

Dock timbers are to be of pine, 12 in. by 12 in. sq., and of proper lengths Joints are to be well broken so as to insure strength. The first course of timbers is to be secured to each pile by one wrought iron



FRONT ELEVATION

FIG. 3 SINGLE CAP WHARF. C.M.&ST.P.RY.



PLAN

FIG 4 SINGLE CAP WHARF C.M.&ST.P.RY.

drift bolt 1 in. square and 30 in. long. Timbers must join over a pile and be halved.

The second and succeeding courses of timber are to be secured to the one beneath by wrought iron drift bolts 20 in. long and ⅞ in. sq. The drift bolts are to be spaced 3 ft. apart on the line of each timber.

Anchor sills are to be of pine timber 12 in. sq. or not less than 16 in. diam. and of sufficient length.

Timbers are to be faced so as to bear against the sides of the anchor piles. The tops of anchor sills are to be placed at datum lines.

Anchor sills are to be spliced at the piles.

The dock timbers are to be anchored to the sill in the rear every 6 ft. by timbers that will square not less than 8 in. at the dock end. The anchor timbers to be of white oak, dove-tailed into and between the different courses of the dock timbers and into the anchor sill, and secured at each end by one wrought iron drift bolt 14 in. long and ⅞ in. diam.

The sheet piling will be driven against a mud sill placed as low as possible near the bottom of the river, and a nailing strip spiked to the lower dock timber. The mud sill is to be 4 in. by 12 in. and shall be pine; the nailing strip shall be of pine 2 in. by 12 in. The sheet piling may be common sheeting consisting of 4-in. and 2-in. planking; or of 3-lap sheeting made up of 2-in. plank. If the former is used the first row must consist of 4-in. pine plank of sufficient length and the second row or batton must consist of 2-in. plank, also of sufficient length.

The sheet piles must be driven plumb and with close joints, the rear row breaking joints over the front row, making a sand-tight dock. All sheet piles must be driven the full length from the top of the bottom dock timber down; no waste to be allowed. The 4 in. sheet piles are to be secured to the lowest dock through the nailing strip by heavy wire nails, not less than 8 in. long, one nail to each sheet pile. The second or batton row is to be secured to the first by 40d nails, two to each plank. All sheet piles must be driven up close to the nailing strip.

If a 3-lap sheeting is used, the sheet piles must be made up of 3 2-in. planks of sufficient length; the outer one overlapping the inner planks not less than 2 in. The 3 planks must be firmly bolted or spiked together so that there is no possibility of their coming apart in driving. The sheet piles must be carefully guided in driving so as to form a perfectly mud and sand-tight sheeting when in place. All sheet piles must rest firmly against the nailing strip and mud sill, and each sheet pile secured to the lowest dock timber by two boat spikes, ⅜ in. by 10 in. long.

TIMBER GULF COAST DOCKS

By A. J. Catchot

Supervisor of Bridges and Buildings, Louisville and Nashville Railroad, Ocean Springs, Mississippi

Our railroad docks on the Gulf Coast are mostly constructed in salt water and we therefore use creosoted piling. Our heaviest maintenance for these docks comes when the piling has had 8 or 10 years of service and when the piles have to be protected with either terra cotta pipe or cast iron casings bolted in sections and jacked down about 3 ft. below the top of the mudline, then filled with sand and capped with about 1 in. of cement for a seal which kills the teredo or limnoria that ravage our piles in salt water. We have some piles which have been protected in this manner for the past 30 yrs. and are carrying trains and still in good condition. We use a 14 in. by 15 in. cap, and a 16 in. by 16 in. stringer rail with 4 in. by 15 in. joists to nail our decking to. All this

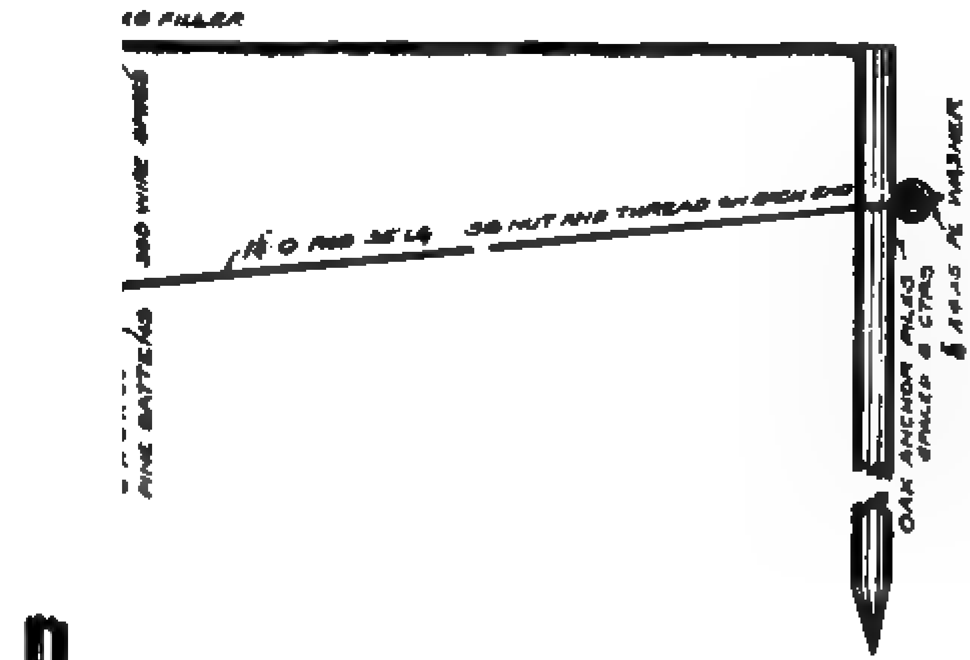


FIG. 5 C.M.&St.P.RY

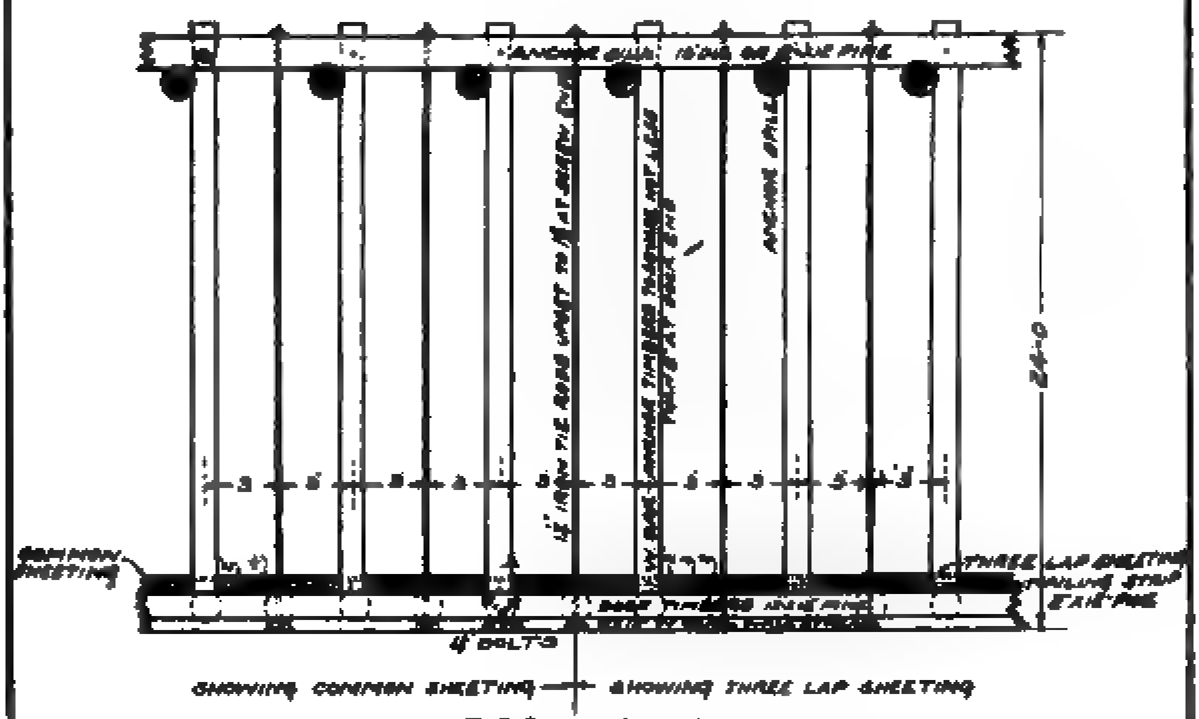


FIG 6 PLAN

FIG 7 FRONT VIEW

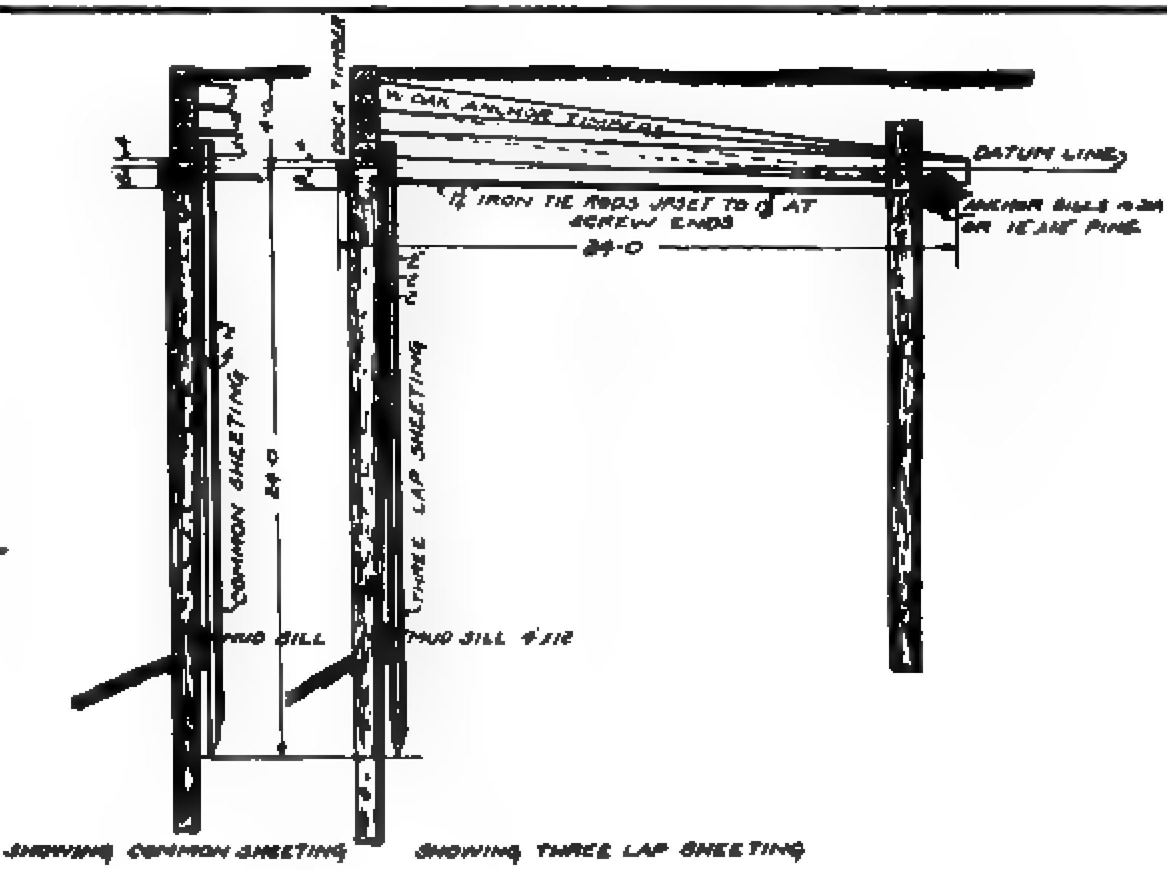


FIG 8 CROSS SECTION

material is creosoted pine. We usually use 3 in. by 6 in. or 3 in. by 8 in. green pine for decking.

The stevedores on ships handling material from cars damage this deck to a certain extent and of course repairs to the deck must then be made at once. We use 50-ft. or 60-ft. green piles hung on the outside of the deck with chains to fend vessels from the dock and find such a fender better than one bolted on, for when vessels strike the dock the piles swinging in chains move up and down and the shock is not so great as against bolted timber. We have some creosoted timber in docks which have been in use 30 yrs., therefore the only repairs are when a storm tears them all to pieces.

Our docks built at interior points such as New Orleans and Mobile are constructed of creosoted piles—in some cases we use cypress chords or joists, 8 in. by 16 in. placed about 3 ft. apart with 3 in. by 8 in. pine decking. This unusual heavy construction is adopted because we handle coal, pig iron and rock on the docks.

We have a diver inspect all our salt water works every year during June or July, and he reports the condition of every pile and we then proceed to protect the piles that are not attacked by the teredo. Any pile found eaten to a depth of 8 in. is redriven. Repairs to the decks are made from time to time as required, taking out a bad plank here and there and on rare occasions renewing the whole deck at one time.

(DISCUSSION)

(Maintenance of Docks)

President Weise:—Now let us get started on this report. It is the first report in this pamphlet. The Committee consists of Mr. F. C. Baluss, Chairman, L. J. Anderson, T. W. Bratten, A. J. Catchot, H. A. Gerst, R. C. Young, F. H. Graham, B. W. Guppy and W. J. O'Brien. Every member of this committee did some work and contributed to the report and the chairman deserves a great deal of credit for getting everybody to coöperate with him. Mr. Baluss, we will leave it in your hands.

F. C. Baluss:—Mr. President and Members of the Association, I don't suppose that our committee had any more difficulty in getting together and formulating our reports than the other committees of the association have had. We organized our work by correspondence and had one meeting of the committee in Chicago at which quite a number were present. We planned the work for the report, the chairman has written an introduction to the subject, and each member of the committee has written on some special phase of this work.

Mr. Baluss reads his section of the report.

R. C. Young:—I suppose there are not very many of this association who have anything to do with timber ore docks, and perhaps these reports may not be very interesting to most of

you, but in getting up this report we went into ancient history a little.

Mr. Young reads his portion of report.

Since we wrote this report the vessel load has increased somewhat. They carried nearly 13,000 tons in one load.

There was so much of this timber that could not be used by our railroad that we sold most of it, at not a very high price. The price of timber went up the next year and we didn't get the benefit of any of the rise in the price of lumber. If we had held our timber for another year we would have gotten probably twice as much out of it, but we sold some of it at from $26 to $40 a thousand as it was, and I suppose it cost about $11 when it was put in there.

F. C. Baluss:—L. J. Anderson, of the C. & N. W. has also written a report on Timber Ore Docks, but due to lack of time we will not read Mr. Anderson's report. I am sure you will all enjoy reading it, but the time is so short that we will now pass on to a report on timber coal docks by F. N. Graham, of the D. M. & N.

Mr. Graham reads his report.

H. A. Gerst of the Great Northern reads report on Timber Docks on the Pacific Coast.

F. C. Baluss:—We also have a very good report from T. W. Bratten of the Southern Pacific Lines on this same subject, but we will omit reading this for lack of time. B. W. Guppy, of the Boston & Maine has written a report on salt water docks adjacent to Boston which I am sure you will all enjoy reading, but we will not read this, as also a report by W. J. O'Brien, of the C. M. & St. P. on timber merchandise docks located on the upper Lakes. We will have a report on timber gulf coast docks by A. J. Catchot, of the Louisville and Nashville Railroad.

Mr. Catchot reads report.

F. C. Baluss:—This completes the report of the committee. The President I believe intends to give a few minutes for discussion.

Chairman Weise:—This committee report is in your hands, gentlemen. You will have an opportunity to read the reports that haven't been read when you get home. They contain a lot of information and show much hard work and the committee deserves a great deal of credit for giving us such a presentable report.

Mr. Johnson:—What is the size of the piles mentioned in the last paragraph " where teredo is allowed to eat in to a depth of six inches? "

A. J. Catchot:—Those piles usually average about 14 in. in diameter, and from that up to 24 in.

Mr. Johnson:—You would have 18 in. of solid pile left, then, on a 24 in. pile?

A. J. Catchot:—You would have 16 in. left on a 24 in. pile, and then the pile is re-driven.

SPRAY PAINTING

REPORT OF COMMITTEE

Painting by spraying, with air pressure, has been in use for a long time, but it has not come into general practice principally for the reason that considerable equipment and skilled operators are necessary for successful work and even then it is used comparatively little except in the case of walls having large areas, box cars and other cars, etc. With special apparatus and skilled help some workmen become quite proficient in this method of applying paint and it is claimed by many that it is more economical to use the spray than to paint by hand. In most instances there is some waste of paint, by spraying, ranging from zero up to 10 per cent or perhaps even more, while most users claim a saving of 50 to 75 per cent in labor by aid of the apparatus. In both instances the results will depend on the skill of the operator.

In days gone by when labor was cheap there was little demand for machine work except for whitewashing and where large plain surfaces were to be covered, but when labor commands the prices of today it seems advisable to go to the limit in testing the method to find if it is not practical and economical to have one or more outfits on each road with a capable, experienced man in charge. Most of those who have had charge of the spray method of applying paint and have given it a thorough test with the more modern apparatus speak in its favor and claim that very satisfactory results may be attained; again there are some who have used the method for years, who state that the results are more often unsatisfactory.

There is no doubt but that the most satisfactory and economical results are attained where a good quality of paint of the proper consistency is used in connection with the best apparatus in the hands of a skilled operator, but this is true of anything. One man with the same materials and same kit of tools will produce far better results than another man; and more especially is this true where slightly complicated apparatus is used.

It will be of interest to refer to the experience of a number of the roads. In so doing the committee will try to be fair in citing the failures as well as the successes of the various trials.

The **Kansas City Southern** used the spray for painting bridges, the interior and exterior of depots and many other buildings, excepting trim work. The results obtained are in proportion to the expertness of the operator. They use 60 to 80 lb. of air by the aid of a portable outfit and claim a good quality of work with a considerable saving of cost, and are enabled to get along with less scaffolding and staging than is used for brush work. Ladders can be used for high work by raising the tank underneath with light block and tackle. The results are generally satisfactory.

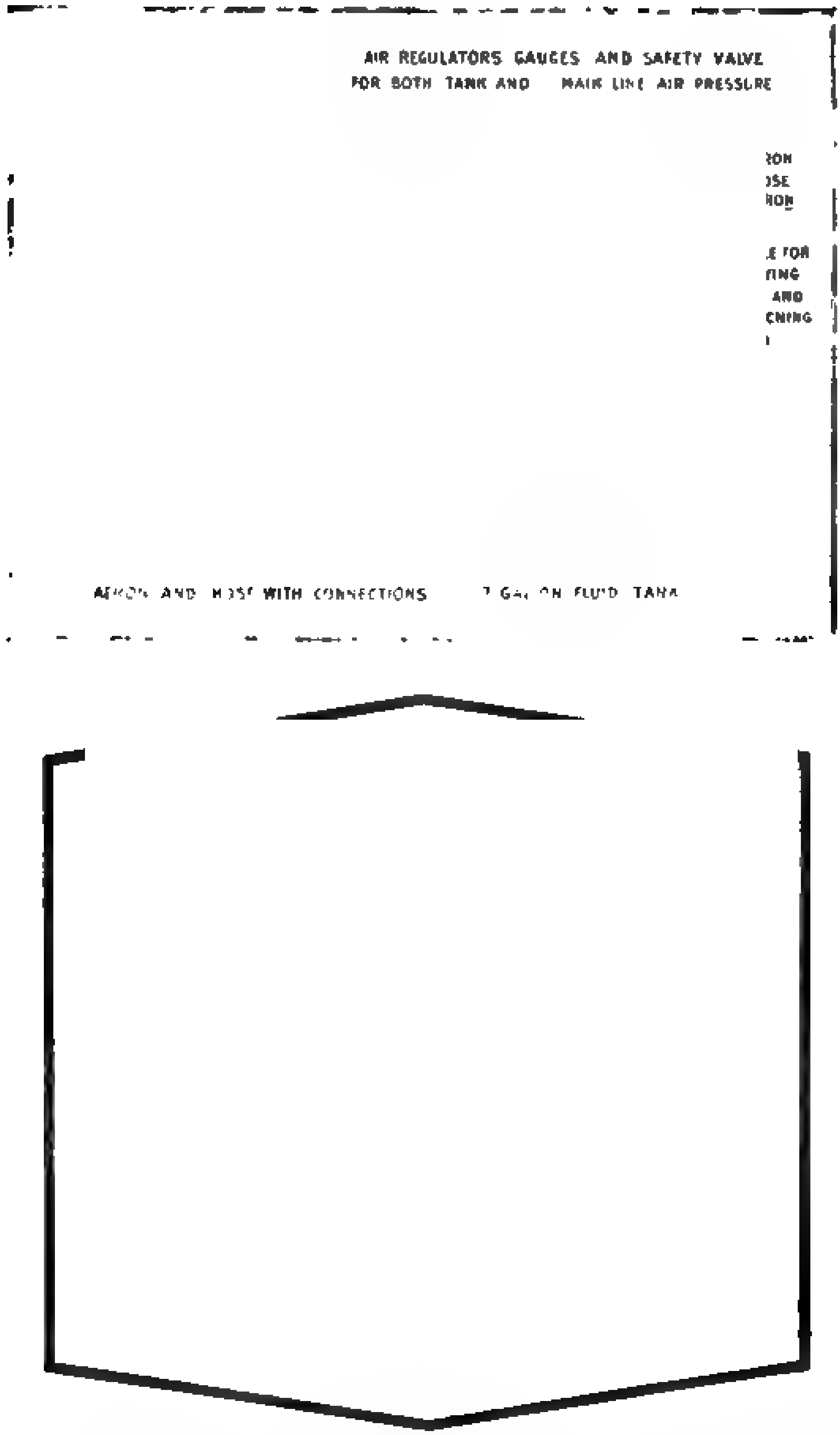
While the **Boston & Albany** has used the spray painting apparatus only about six months on bridge work the supervisor of bridges and buildings seems to think there are no limitations to the practical uses of the method. He recommends the spray for whitewashing, painting large surfaces and in reaching inaccessible places, and the brush for lattice work, trimming, etc., and for touching up any poorly applied spray painting.

The bridge and building department of the **Baltimore & Ohio** has used the paint spray for about 20 years. It has found that the best results are obtained with the use of small portable outfits with 85 to 90 lb. pressure, on bridges, buildings, fences and freight cars. It is best

Spray Painting on Truss Bridge Work

adapted to rough work where a large surface is to be covered with a cheap or medium grade of paint and a fairly good job can be made without brushing. On smooth surfaces where the best finish is desired it is best to follow up with hand brushing. On ordinary work where it is not necessary to follow up with the brush there is a saving of labor of 65 per cent with an increase of materials of only about 10 per cent. They do not recommend its use for lattice work or where there is considerable trim work. Some bubbles are formed where smooth surfaces are covered and these must be brushed out. It is necessary to protect workmen from inhaling the fumes and this can be accomplished by the use of a dust or gas mask or a wet sponge. They use their own sprayers.

The **Michigan Central** has not used spraying machines for painting bridges and buildings but it has used them for 3 years in painting freight equipment, passenger car underframes and trucks, locomotives below the running boards, and other miscellaneous work in and about car shops, with entirely satisfactory results.



Spray Painting Outfit

"We get a better job and can show a saving of both labor and material. Our men complain on account of the fumes from the spray but they can avoid these and their complaint is in reality merely on account of the saving of labor. While our experience has been limited to the painting of equipment we believe there should be no limitation to the use of this method of painting if handled by competent operators. Our outfits are portable and we use an air pressure of 80 to 100 lb.

"One coat of paint with the spray is equivalent to two coats with the brush, especially on trucks and underframes of passenger cars, freight cars and locomotives. There is a saving by the machine method in both material and labor, the latter amounting to fully 50 per cent. We make our own sprayers, using the vacuum system whereby it is not necessary to carry any air pressure in the paint tank. We can apply the paint from a ladder, staging or scaffold,—in fact anywhere that a brush can be used, and in many places where the brush could not reach."

The **Delaware, Lackawanna & Western** has used the spray in the car department for 25 years but does not use it for painting bridges and buildings. Sometimes the results are satisfactory but more often not. Inferior work is turned out unless the surface to be covered is entirely flat, on account of all parts not being thoroughly covered. Moisture introduced into the paint through the air compressing process is detrimental. The use of the machine is best adapted to the application of water paints or distemper color in new or unoccupied buildings where the dropping of paint can be permitted and the expense of protection and covering can be avoided. It has been found impossible to reach inaccessible parts. In the opinion of this road the use of the spray machine for painting should be confined to flat surfaces easily reached, such as freight cars, trucks, locomotives, etc., and other more or less unimportant work.

Generally speaking, paint sprayed does not compare favorably with brush work. Years ago comparative tests were conducted which showed a saving of labor in favor of machine work and a waste of material. Usually the extra material required would more than offset the saving of labor effected. In many cases the paint could be applied successfully with the apparatus and then leveled off with a brush. If this is done the places which the spray is apt to miss will be taken care of and the surplus or runs can be wiped up.

This road has never used portable outfits. The air pressure necessary varies from 50 to 80 pounds.

The **Southern Railway** has been using portable outfits for various kinds of work with air pressure of 60 to 80 lb., working from ladders, staging or scaffolding, with piping and hose for bridge work, and hose only for building work. Trimming work is done by the aid of a light metal shield held in the hand of the operator.

This road reports that there is very little work that cannot be successfully done with the machine but until the operator becomes expert it is probably best to apply paint on lattice work and trimming with the brush. One man with the machine can do the work of three with the brush and with much less exertion. The expense of labor is reduced 75 per cent. The work can be done successfully with ladders, staging and such apparatus as is generally used for brush work. No trouble has been experienced with air bubbles if the paint is properly mixed and the apparatus properly adjusted.

The **Long Island** uses a sprayer of its own manufacture in applying paint successfully on buildings with large unbroken areas. It uses about 20 per cent more material than by hand, with a saving of about 80 per cent in cost of labor. Air pressure ranges from 80 to 100 lb.

The **Erie** developed a home-made apparatus about 14 years ago for painting cars and some large buildings such as stations, docks and warehouses. The work done with it at that time was not considered equal to brush work and its use was discontinued.

The **Southern Pacific** uses the spray for applying paint to bridges and buildings as well as for freight cars and other equipment and finds that in the hands of an experienced operator it can be used for all purposes except on trim work with very satisfactory results as compared with brush work, and with the loss of very little paint and a great saving of labor. One outfit uses an air pressure of 50 lb. while another uses as low as 12 lb. at the nozzle. No bad results are experienced from air

bubbles. Masks are sometimes used by the operator but more often not. The spray reaches inaccessible parts much better than the brush.

The **Nashville, Chattanooga & St. Louis** has used the paint spray for 12 to 15 years on freight cars, underframes, castings and shed buildings. It will reach places that can not be reached otherwise. They use it very little, if any, for bridge and building work.

APPENDIX A

Comparative Tests of Applying Paint by Spraying Machines and by Hand on Government Buildings

(From Engineering News-Record of Feb. 25, 1920)

An interesting account of a test of methods of applying paint by spraying machines appeared in the Paint, Oil and Drug Review. The information was obtained from a private source and is considered as fair and accurate as any individual statement can be. Everything possible was done to make the test thorough and indicative of the results that are to be expected from spray-making machines. The tests were made in government buildings.

The machines used at the United States Naval Hospital, on Sept. 17, 1919, consisted of a 4 h. p. motor with a large air tank and a 5-gal. paint tank. The apparatus operated with a 220 volt direct current. An experienced spray brush operator started the spray on one side of the building, and two experienced journeymen painters with 4½-in. brushes started on the other side of the building, which was an exact duplicate in shape, size and form of the side selected for the spray tests. After the cylindrical end of the building was completed, which was about one-fifth of the area of the whole building, a painter entirely unfamiliar with the use of the spray gun was shown how to operate it, and he completed the tests, including all walls and roof area. In this connection it is apparent that a very short period of time is required to instruct a man unfamiliar with the use of the spray gun with its working. Following is a summary of the data obtained from the tests:

Wall Tests—(Exterior)

Method of application	Area of surface sq. ft.	Paint used, gal.	Time 1 man, hrs.	Spreading rate per gal. sq. ft.	Time to coat 100 sq. ft. min.
First coat:					
Machine,	4,182	6.5	9½	570	13.5
Brush,	4,094	5.97	20	648	29
Second coat:					
Machine,	4,182	4.3	10½	863	15
Brush,	4,094	3.9	21	992	30.7

In addition to the wall tests, data were obtained on the coating of a large area of the roof with the paint spray machine. Nearly 9,000 sq. ft. of area was coated with 22½ gal. of paint in 14 hours by one man. This included the time of mixing the paint, placing it in the containers, raising the machine to the roof, etc. It should be noted that the average journeyman painter, working on wall work, will do about 200 sq. ft. an hour and about 250 sq. ft. an hour on roof work. It will be seen from the preceding table that the journeyman painters apparently speeded up their hand brush work, as they were very much interested in the test, and they accordingly made very much higher averages than the figures just given. The results for the roof test follow:

Method of application	Area of surface sq. ft.	Paint used, gal.	Time 1 man, hrs.	Spreading rate per gal. sq. ft.	Time to coat 100 sq. ft. min.
Machine,	578	1.49	½	386	5.2
Brush,	578	1.35	1½	428	15.5

The paint used on the work was a white lead paint, the materials for which were furnished by the Government and mixed by the men. It was tinted with ochre. The first coat weighed 17.6 lb. per gal. and the second coat, 20 lb. Both of these paints were easily handled by the spray gun. From observations, it is apparent that the spray gun will successfully handle paint of practically any weight per gal.

On the first coat all cornices and trim were cut in with the spray gun on the side of the building where the spray gun was used. On the second coat, however, the cornices and trim were cut in with the brush to be sure of a neat job, and the time for this brush work was counted in as spray gun time.

Observation of the character of finish given by the spray versus the hand brush work on the completed first coat showed a slightly more uniform film for hand brush work. On the second coat there was no apparent difference in the appearance. Both coats dried in about the same period of time, whether applied by spray or brush.

In the roof work the paint tank was hoisted to the roof, and two hose leaders carried from the spray machine located on the ground. Two operators could work at the same time with the paint tank, which was fitted with two spray guns. The paint used for the roof work was a red oxide of iron paint. Only one coat was applied, which gave very good hiding power. Even in this work which was done on the roof of the building, subjected to strong currents of air, there was apparently not very much loss of paint, the pebbled roofing showing probably less paint loss by dropping than where hand brush work was used. It was observed, however, that the overalls of the painters using the spray gun became somewhat more soiled than where hand brush work was done.

Another test was made at General Pershing's headquarters, U. S. Land office, on Oct. 3, 1919.

This test was conducted with a modern interior lithopone flat paint of cream color for the ceilings and light buff for the side walls of a series of rooms in the Land Office building. Both paints weighed 14 lb. per gal. In the tests upon which data were obtained, one room was done by two painters with brushes, and two rooms were done with the spray gun by one operator. The rooms were on the second floor of the building. The machine was placed in an interior courtyard, with hose leaders running up to the rooms. The following is a summary of the data obtained:

Method of application	Area of surface sq. ft.	Paint used gal.	Time 1-man hr. min.	Spreading rate per gal. sq. ft.	Time to coat 100 sq. ft.
Ceiling:					
Machine, ...	660	1.64	1 50	402	16.5 min.
Brush, ...	250	.50	2 30	500	60.0 min.
Walls:					
Machine, ...	1,490	4.75	3 30	408	10.8 min.
Brush, ...	750	1.25	2 50	600	22.6 min.

It will be noted from the above chart that especially good results were obtained on the ceilings with the spray apparatus. This method of painting seemed to be very much preferred over the ordinary method of application by hand brush. The ceilings were all arched, four arches meeting in the center of the room. The side walls had four projecting columns, one at each corner, and between the tops of these columns and the arches of the ceiling there was over a foot of school cornice. Each room also had a chimney projection and large recessed combination windows. The surface, therefore, was not of the ordinary type.

The hand brush work was marred by streaks and in places the covering was poor. The spray gun work was much better, as a heavier coat of paint could be applied.

During both the work on the naval hospital and on General Pershing's headquarters, it was found that the journeymen painters did not seem at all hostile to the use of the spray gun. In fact, after they had become accustomed to it some of them became very enthusiastic about its use, stating that they were less fatigued at night than when they used hand brushes, especially on certain types of work. It would appear, therefore, that journeymen painters, after they have had a little experience with the gun would become enthusiastic regarding its use on certain forms of their work.

APPENDIX B

By James R. Shean, Los Angeles, Calif.

About 20 years ago a Boston painting company developed and used a hand pump spraying machine for applying water color on buildings, and a few years later, using a gas engine for power, applied oil paint successfully with a spray. This was probably the beginning of spray painting. Results obtained at that time demonstrated that with improved apparatus, the application of paint by spraying, was not only practicable, but would be more economical than applying it with a brush. Development of spraying machines did not advance very rapidly in building construction, however, until the unprecedented demands on the painting industry caused by the war, made it absolutely necessary to find some method of applying paint, which would overcome the scarcity of labor and brushes.

Nearly all of the present day spraying outfits are composed of three units, (1) the compressing outfit, consisting of an electric motor or gas engine, air compressor and air reservoir, which are generally mounted on some form of portable truck. (2) the paint container which may be had in different sizes, and which has pressure regulators, check valve, etc., attached to it. (3) the spray head and hose.

As a rule the gas engine is more practical than the electric motor as it is not always possible to get suitable current for the motor. In selecting an outfit care should be taken that the engine or motor has the right capacity for compressing the required number of cubic feet of free air per minute to insure a steady pressure as long as it is needed, for no one can turn out satisfactory work with a sprayer unless there is a steady pressure behind the material. The mechanical construction of this unit should be as simple as possible, so that the average painter will be able to understand its working, and thus eliminate lost spraying time. The paint container should be large enough to hold sufficient material to cover a good sized surface without refilling. The weight of the container when filled should be given some consideration, as it is sometimes very unhandy to move anything heavy around on staging, etc.

The type of spray head and the kind of hose should be well considered. The air hose should be of rubber and the material hose of some composition material which will withstand the action of the oils and other materials, which are forced through it. They should be as light as possible, as a man on a plank 25 or 30 ft. in the air has that much weight dragging on him all the time.

The spray head itself is the keynote of any spraying outfit. Most of those on the market are efficient, but some are so constructed mechanically, that there is an excessive wear of moving parts. This is especially so when the material is forced through the head. Nearly all paint materials, but especially water colors, are more or less gritty, and cause a certain amount of abrasive wear on valves. The most satisfactory heads carry the material through a separate channel and force it out in front of the stream of air at the nozzle. This eliminates nearly all wear on the different parts of the head.

About 80 lb. is the average air pressure required for work up to 30 ft. in height. The pressure behind the material can be much less, as only enough is needed to force the material from the container to the head.

The one predominating feature of this method of paint application is speed. An experienced operator using the ordinary staging can cover 5,000 sq. ft. in an 8-hr. day. Tests made in Washington under actual working conditions showed that spraying used approximately 10 per cent more material than brushing, but brushing required nearly 200 per cent more labor than spraying. In addition to this saving in labor, there is the additional saving of getting the same results with two coats sprayed on, that are obtained with three coats brushed on.

While it is generally assumed that any man can use a sprayer, it has been the writer's experience that about one man in four is able to apply a good even coat, free from "Holidays" and not waste material. Most men think they should jump all around over the surface, much the same as one waters a lawn. This idea is entirely wrong. In applying the paint, the head should be held a certain distance from the surface, generally about 12 or 15 in., and moved in straight stretches across the work, either horizontally or vertically, just fast enough to cover the work thoroughly, without runs or sags. Each stretch should overlap the last one a little, as naturally the paint stream is bound to be a little thinner at the edges than in the center. Overlapping insures an even film on the whole surface. It has been figured that about 80 per cent of the painting can be done by spraying, the other 20 per cent will probably always have to be brushed on. With the improved spray heads of today, the operator can cut close to openings, but if necessary light frames covered with cloth or paper, can be placed in front of windows, etc., thus insuring clean window glass. A little sawdust thrown along the foot of the wall will help protect the floor, but a good operator will not need much help to keep the floor clean.

In railroad work, coal chutes, roofs of buildings, board fences, section houses, interiors of engine houses, shops, etc., can be sprayed at an immense saving in labor. Plate girder bridges can also be sprayed but truss bridges, where there are so many rods and other small surfaces, can probably be painted as cheaply with brushes. On steel work, especially new steel, it is a question whether or not a coat sprayed on will give the same protection that a coat brushed on will. It hardly seems probable that the force of the paint striking the surface will fill the pores as well as good brushing. It seems that spraying will have a tendency to bridge these pores instead of filling them, which is so essential for the proper protection of metal. There is some opposition to spraying on account of danger to the operator's health from inhaling the fumes, but this can be eliminated by putting a small piece of China silk in an ordinary respirator.

In closing it might be well to quote Henry A. Gardner, who says: Any legitimate and satisfactory means of application of paint and varnish should be well received, not only by the master painter, but by the journeyman painter, and the public: And any device which creates new business in new fields, is to be given the hearty approval of all, if found to be of a practical nature.

SOME SUGGESTIONS ON SPRAY PAINTING

By C. B. Lyons

(Railway Maintenance Engineer, December, 1920)

The progress made by paint spraying equipment in the last few years, especially in the structural field, should be of interest to all. There was some question as to the feasibility of using it on exterior wood surfaces, but after considerable experimenting spray painting is advocated for small structures, such as houses and the like, and although painting in this field is still in its infancy, the tests conducted are convincing proof of its practicability.

In large structural work the saving in labor and time is the prominent feature. The work is done at the rate of 500 sq. ft. and upward per hour, or in one-fifth the time required by brushing, thus increasing the output and efficiency of the gang. These figures apply equally to the application of mill whites, calcimines, lead and oil paints for interiors and to mineral and lead and oil paints for exteriors. The waste of material is small, for while running in some cases to 10 per cent, the average will be found to be less than 5 per cent. The paints used are generally of the same consistency as for proper handling with a brush.

When using spray equipment on exterior surfaces of wood, care must be taken not to apply too heavy a coat. Best results are obtained with paints ranging from 12 to 15 lb. per gal. Ready mixed paints or lead and oil mixtures should be reduced to this consistency. Small trim on two-color work is done with the brush.

Speed combined with quality is the aim of spray equipment manufacturers. A speed of 500 sq. ft. per hour is very conservative under working conditions. Cases have been reported where on certain classes of work as high as 2,000 sq. ft. per hour had been covered in one hour. The waste depends entirely on the operator. Using higher air pressures than are actually required and holding the spray at an improper distance from the work are factors causing the waste percentage to rise. Just enough air pressure should be used on the material to cause it to flow freely through the hose to the spray. When working on the ground a pressure ranging between 5 and 10 lb. will be found sufficient. To this should be added approximately a pound of pressure for each foot in height. Too much pressure on the paint will force more material to the nozzle than can be atomized properly, resulting in sags and unnecessary waste of material. Proper pressures for atomizing paint are difficult to specify, but on the usual run of paints it should be 40 to 50 lb. More pressure than is actually required to atomize the paint thoroughly causes excessive vapor. The work should be done with as low air pressures as possible.

The proper distance for holding the spray from the surface is six to eight inches. To avoid complications paints, when used with spraying equipment, must be properly strained. Any paint from cold water to red lead can be sprayed successfully. Always specify the kinds of paints to be sprayed when ordering spray equipment. To have an efficient machine, one that responds when called into service, it must be given attention. Cleaning and oiling are important in the life of spraying equipment.

An exterior spray coat is as lasting as a brush coat. This has been clearly demonstrated by tests conducted on residences by one of the leading spray manufacturers. Brick, concrete, steel and wood exterior surfaces spray-coated have stood the test of time as well as brush-coated surfaces of like nature.

(DISCUSSION)

(Paint Spraying)

J. J. Wishart:—I don't see how you can paint a bridge without first cleaning it and in order to clean it you have got to have a proper staging. I would like to ask how the bridge is cleaned before it is sprayed.

President Weise:—Has anyone had any experience in cleaning a bridge and painting it with a spray at the same time, in other words, combining the cleaning and the spraying operations?

Secretary Lichty:—I think we should omit a discussion of that for the reason that I don't think anybody would recommend painting a truss bridge with a spray outfit. If they do, we would be glad to hear from them. There is no use of going into a discussion of staging for cleaning iron if we are not going to talk on things that pertain to the painting of it.

J. J. Taylor:—I have had some experience. We have been using the spray for a couple of years in painting shop buildings and depots and a good deal of bridge work. We have had very good success in painting bridge metal by spraying, that is, the larger members such as the floor beams. It is expensive to spray the smaller parts, the lattice work and small members, on account of the loss of material. The only objection I have to the spray method is the loss of material on the small members. On the walls and larger surfaces where the openings are not too numerous, you can protect the openings with canvas or something and can certainly make good headway and do a good job of painting with a spray. We use it in every kind of painting, inside and out. Of course, we have to follow up and do a lot of brush work and finishing up, but it is a great time saver. We think a great deal of the spray machine.

T. B. Turnbull:—We have not had any experience with paint spraying of any kind, but we are thinking very seriously of it. Everybody knows that in painting bridges there are many places that are not and cannot easily be reached with a brush, and that is not only true in painting a bridge, but also in the cleaning. It seems to me that if anyone is going to use a spraying outfit he would have a sand blasting outfit with it in order that the bridge could be cleaned particularly in places that cannot be reached with brushes, tools and scrapers. Therefore, it seems to me that

unless there is some serious objection to the spraying method, it would be much better than brush work on a great deal of our work. Now I am just saying what I think, and if anybody has had any experience in the matter why, that is what we are all after.

G. W. Andrews:—Mr. Lichty made a remark that probably I didn't quite catch, but I understood him to say that no one would think of painting a truss bridge with a spraying machine.

Secretary Lichty:—I believe I made that statement. If any one has used the spray successfully in painting bridges we would like to hear from them.

G. W. Andrews:—I want to give him a chance to recall it. I will agree with him in part, that in the small web members you probably would not consider using a spraying machine because of the amount of paint that would be wasted for the small surface covered, but the floor beams, the cover plates of the end posts, the top or bottom chords, the insides of the chords, and incidentally the lattice bars on the end posts, and the chords, could all be painted and are being painted with a spraying machine with economical results, and I know that we are doing it. The spraying machine can be used on plate girder or I-Beam bridges and reach parts which cannot, as has been said, be reached with the brush. We often have to use, as many of you here know, the sheep-skin or swab and we do away with that in the use of the spraying machine. We can use it on freight houses with equal facility, or on any building where there are not many openings in the way of windows and doors to take care of. As a matter of fact, you can use it even on those if you want to exercise care and reduce the paint to suit the space that you cover, but I don't believe it would be economical on buildings of that character, although it is economical on freight house buildings and on the metal roofs of buildings.

Something has been said about the cleaning of a bridge. Of course this subject has no bearing on cleaning, and I question whether we should discuss it, but it is a well-known fact that no man would think of using paint on a structure until he had cleaned it off. If he did, he ought to lose his job right away. You can use the spraying machine in conjunction with sand blast machine or if the sand blast machine as in many cases is objectionable to the men using it on account of the severe heat in the summer, and the objection to wearing helmets, then the air can

be used for blowing off the dust when scrapers or wire brushes are used using the straight nozzle instead of the paint nozzle, with about a quarter inch opening. The dust can be blown off far better, easier, and more economically than it can possibly be removed with a brush. Then you have a good clean base to use your spray on. We have recently used the spray on a large amount of fencing on pens around our tracks at a large race course in the vicinity of Baltimore, requiring several thousand square feet of paint, and we painted that at just about twenty per cent of the cost of the former application by hand. We painted that entirely by the spray method. Of course you must have air, but that is another question. You can buy small spraying pumps operated by hand, but they are not efficient for a large amount of painting, and I question very much whether they are economical, but many of the railroads today are using the pneumatic tie tamping machines, and that same outfit makes a most excellent outfit for spray painting for either bridges or buildings.

Chairman Weise:—Mr. Robinson has come now and we will give him an opportunity to make some supplementary remarks to the committee report.

J. S. Robinson:—I was very much opposed to spray painting because I considered it very extravagant in the use of materials. For instance, we had one of our large Chicago structures painted with it recently, and it not only took ten per cent, but two hundred per cent more paint than it would have done by hand. It was a very difficult structure to get at, the work was very poorly done, presenting a mottled appearance and it was awfully extravagant in the use of paint. Now paint spray, if put on properly, will make a very nice looking surface but I think generally, and this is the opinion I have formed from my investigations, it ought to be put on in two coats. I don't think you can get a paint spray that looks well, especially on metal, with one coat. Now in the structures that I speak of the girders ran over the bridge beams, and to get around to the end of the cross girder or strut at the end they used considerable paint and were not very successful. Finally they had to resort to the swab and the long handled brush to get at that part of the structure. I consulted the Library of the Western Society of Engineers, in Chicago and got considerable data from there, most of which came from government publications. The reports that I saw

showed from 15 per cent to 25 per cent increased quantity of paint, but from 50 to 65 per cent less labor, and they all showed that in government work it was done on flat surfaces like girders and it was also very successfully used on flying machines.

The spraying of varnish was found very difficult at first, but they finally designed a nozzle with which they could spray on varnish and make a good job of it. The consensus of opinion in all the reports that I saw was that it is simply a time saver, and that was the government's idea in using it. The war, of course, we all know, meant waste, and they were for getting all the surfaces painted quickly and as well as they could, but time was the great thing, so they didn't particularly try to save material, although in their tests, they did. They found this method was extravagant in the use of material, but the time saved by using the spray was very great, and the work done was very evenly done where they used two coats, and they finally considered it a success.

Now in our work, both painting the girders in shops and the trusses in the roofs and all that sort of thing we found it very extravagant in the use of material, but it did the work very well and is a great time saver.

Member:—What make of spray do you use?

J. S. Robinson:—We had one that we made ourselves.

G. W. Andrews:—Mr. Robinson is right about the waste of material, but that wastage is comparatively small as compared with the time saved and the labor. At the present high rate of labor we can afford to waste some materials. Now I will cite one example of hand painting that we just recently completed. The Susquehanna Bridge between Baltimore and Philadelphia is a mile long and double track. We painted that two years ago and this year we put on an additional coat. It took within a fraction of 100 barrels of paint, or 5,000 gallons. The contract for the labor for applying that one coat was $20,500, just a fraction over four times more than the cost of the paint. Now I think most of you will agree with me that only a few years ago our estimates for painting of bridges usually brought the labor about double the cost of the paint. But now it is four times the amount of paint, and we can afford to waste quite a good deal of paint if we can cut down that labor. I feel sure that if we had put that on with the spray we could have cut it down twenty-five per cent, and we wouldn't have wasted over ten to twelve

per cent of material, if we had wasted that much. This large fence that I was just speaking to you about, the wastage on that wasn't over five per cent. If we could have gathered the paint up off the ground I am sure it wouldn't have been more than five per cent.

Now we saved nearly sixty per cent of the labor over former prices for applying it by hand, so I think if we go into it closely we will find that we can afford to waste material if we can save labor at the exorbitant prices that we are now paying for it.

J. S. Robinson:—I wish we could make our needs complete. The materials are generally a very hard thing to get. They expect us to furnish the labor in all cases with the least possible materials.

Chairman Weise:—I am satisfied that this question of paint spraying is one in which there is a great deal of interest, and it is still largely in the experimental stage. Many are trying it out in one form or another, and we are going to get results as we go on. We have a letter here from G. W. Rear, of the Southern Pacific, in which he states that they are using spray machines but have not had them in service long enough to furnish us with reliable data.

It seems to me, as the committee has brought out here, it is largely a matter of experience. There are certain conditions under which a paint spray will not work satisfactorily; for instance, I believe that a great deal of paint will be wasted in a heavy wind, and it wouldn't pay to operate then. In bridge work it is sometimes hard to do work without working in the wind.

J. S. Robinson:—I saw a test made in the wind, quite a strong wind, thirty miles an hour, the gun being used on a flat surface. The operator held it about four or five inches from the metal and there was very little waste on account of the wind. It was very successfully done, but of course he was a very experienced man, in fact he was the man demonstrating the machine, but it proved that it can be done without much waste, even in the wind.

THE MAINTENANCE AND REPAIR OF FREIGHT HOUSE FLOORS

COMMITTEE REPORT

One of the prime needs in a modern freight house, especially where much trucking is done, is a smooth floor, and one of the perplexing problems of a building supervisor is to keep this floor smooth at all times. The length of life and wearing qualities of a freight house floor and the frequency with which repairs or renewals are required, is very problematical, depending not alone on the materials of which they are constructed, but also upon the class of labor employed on installation, the traffic and equipment passing over them and upon the climatic and physical conditions characteristic of the locality where the floors are laid. A floor which stands up well in one freight house may prove unsatisfactory or an utter failure in another. The need for keeping a freight house floor smooth is two-fold, first, to facilitate the movement of trucks in order that the men may handle the maximum amount of freight with the minimum expenditure of time and effort, and secondly, to reduce wear and tear on the trucks as well as on merchandise, to a minimum. It is therefore within the scope of this subject to study the various types of floors which are adapted to freight house service, their construction and the manner in which repairs and renewals can be made most readily and economically.

When deciding upon the type of floor that is best suited for any freight house, consideration should be given to the available materials, the nature of the freight to be handled, the amount of trucking that must be done, the climatic and physical conditions, **the ease with which repairs or renewals can be made when needed,** and in connection with this perhaps the probability of having to abandon the use of portions of the floor during repairs. Initial or "capital" cost, while of great importance to the subject of this paper, has not been considered to any great extent. It is felt that this report is too broad in its scope to dwell too much on the question of initial expenditures. However, it is recommended that when it is necessary to obtain a floor which will guarantee long life and low maintenance and at the same time insure the qualities which are characteristic of good floors, initial cost should not be spared to attain that end.

Floors may be classified according to the materials of which they are constructed into the following types:

A—Wood floors of plank or flooring in which the grain of the wood is parallel to the floor surface.
B—Wood floors covered with metal plates.
C—Wood blocks or paving in which the grain of the blocks is at right angles to the floor surface.
D—Brick, such as are used for sidewalks and street paving.
E—Asphalt or mastic.
F—Concrete.

Concrete is frequently, if not usually, used as a sub-base or foundation for some of the other kinds of floors.

Several types of patented floors have been investigated but as they are untried to any great extent in railroad service no reliable data as to their economic or wearing qualities are available, and therefore they are not specifically mentioned.

A. Wood Floors

(a) Yellow Pine Floors.

A yellow pine floor is more widely used than any other type, and considered from the point of first cost only, is the cheapest floor that can be constructed, particularly in a timber country. It can be used to advantage where trucking is not heavy, and in new buildings where deep filling is required inside the foundation where settlement is likely to occur. Long leaf yellow pine is preferable to short leaf and has a probable life of 8 to 12 years, depending upon the character of traffic.

Figures A, B, C and D show various types of this floor in use. Figure A is common to all localities and consists of 2-in. plank, unmatched, and face-nailed to wood beams or joists. The floor illustrated by Fig. B is recommended by the American Railroad Association.

Repairs can be made readily to yellow pine floors and when planks are broken or damaged, they can be removed and replaced easily, but after the floor is worn considerably, this results in an uneven floor. It is possible after such a floor is considerably worn to take up the planks and relay them with the bottom side up, using shims to secure an even bearing on the joists.

(b) Hardwood Floors.

Hardwood floors of maple, beech and birch have been used extensively for years as a top finish wearing surface upon a sub-floor of yellow pine or other similar wood. This is particularly true of maple, which makes a very serviceable and durable floor. Fig. B shows the general method of laying these floors. Sometimes this type of floor is built on a concrete foundation, in which case the underfloor is nailed to nailing strips embedded in the concrete. It is recommended that the flooring strips or screeds be of creosoted material because experience has shown cases in which they have rotted and could not be easily replaced. The type of floor, as illustrated in Fig. E, was recommended by the American Railway Association in its 1914 report for its durability and all around good service. However, the New York Central, in its machine shop at Harmon, N. Y., laid this type of floor in 1906 but it had to be replaced by a concrete floor after 10 years of service, due to dry rot in the under floor.

The "Soo" Line, the Illinois Central, the Pennsylvania, the Missouri Pacific and the Grand Trunk have maple floors in service, with an average life of about 20 years, and the Missouri Pacific has quoted a maximum life of 30 years. There is no record of any railroad having used a hardwood finish without a sub-floor, but it is suggested that this might be used in places where water is on the floor frequently. Decay develops quickly in double floors subject to such dampness and it is thought that a heavy single hardwood floor will outlast a double floor on account of the elimination of such decay. In order to overcome dry rot in double floors on sleepers or concrete foundation it is necessary that no accumulations of dust or rubbish be allowed and the floor should be so constructed as to allow for the circulation of air. A floor of matched lumber is not as easily repaired as the other type because the strips of flooring cannot be taken up without damaging the tongue and groove.

The Illinois Central has used maple flooring for freight houses for many years. This flooring is end matched only, the sides being left square and is about 3 in. wide. If laid on a concrete base, 2 in. by 4 in. screeds are imbedded in the concrete, on top of which is placed a deck of 2-in. lumber, varying from 2 in. by 6 in. to 2 in. by 10 in., preferably creosoted and thoroughly nailed to the screeds. The maple flooring is then laid at right angles to the 2-in. plank, and thoroughly face nailed, spacing the nails near the edge of the flooring. This, together with the end matching, forms nearly as smooth a floor as though it were edge matched and without question is longer lasting. It also saves ½ in.

on every piece that is taken up by the matching. No warping has been observed and no more trouble from bulging on account of the absorption of moisture than with the edge matched floor. It is desirable that the 2-in. plank used as sub-flooring be creosoted, as this will prolong the life of the floor. When the floor is laid over wooden joists the same method is followed, namely, a 2-in. pine sub-flooring with maple flooring laid at right angles. This type of floor is in use at the in-freight house at East St. Louis and in the freight house at La Salle, Ill., and is giving excellent service. Many roads lay the hardwood surface flooring diagonally, and while this causes some waste of material it tends to prolong the wearing life of the floor surface.

On the Louisville & Nashville, freight house floors are built of 2-in. shiplap or rabbeted long leaf yellow pine or oak. The floors in a number of buildings where the trucking is light are 15 years old and in fair condition. The freight house at Knoxville, Tenn., has a 2-in. pine floor as above, a part of which has been in for 15 years, although that part that is in the truck-way requires renewal about every 4 years. Timber floors have so far been found most economical on this line, but because of the increased cost of lumber floors of other kinds are being considered.

On the Erie the standard wood floor for freight houses was of 2-in. plank, but these were easily broken by trucking and much trouble was experienced. It is now the practice, when renewing such floors, to use 3-in. plank, as they are found to be more satisfactory.

At the Pennsylvania's Duquesne freight station in Pittsburgh a floor surface with tongue and groove maple has been installed, which is fairly satisfactory. This type of floor gives good results except where trucking is excessive. Its chief disadvantage is the difficulty of making repairs without renewing the whole surface. It requires the service of one man constantly to keep this floor in good condition. In the Grant street freight house at Pittsburgh a concrete retaining wall was built along the tracks and the space filled in to an elevation 6 in. below the top of the wall with cinders. Stringers of 4 in. by 6 in. yellow pine were laid flat on the cinder filling with 1¾ in. yellow pine on top of them. On this was laid 1⅛ in. by 2¼ in. hard, dry maple flooring, bored and end-matched. This provided an air space of 3 in. between the bottom of the floor and the cinder filling. This floor lasted for 10 years without any repairs, at which time the 4 in. by 6 in. yellow pine stringers developed dry rot, making repairs necessary. It is thought that this dry rot could have been prevented if air vents had been provided in the concrete between each stringer, permitting the free circulation of air. In renewing the floor the 6-in. yellow pine stringers were laid parallel to the tracks and the maple flooring diagonally. It was found rather expensive to make the repairs because the flooring was laid diagonally and only one stall could be spared at a time owing to the large amount of trucking. It would have been more economical to have laid the flooring at right angles with the tracks or to have made a straight joint between each stall. In the Carnegie freight house, built in 1906, where a heavy business is done, the floor consists of 3 in. by 12 in. joists placed on 12 in. centers and covered with 1-in. hemlock for the underfloor with 1⅛ in. maple flooring above bored and end-matched for the top floor. The floor is about 3 ft. above ground and is in good condition today.

On the Bessemer and Lake Erie the usual floor in the smaller freight houses consists of 2 in. by 12 in. or 3 in. by 10 in. joists placed on sills on which is laid a 2-in. white oak plank floor.

B. Wood Floors Covered With Metal Plates

Investigation discloses but comparatively little use of floors covered with metal plates in railway freight houses. Where used they are

largely runways where the trucking is unusually heavy and good service is reported. If plates are used they should be roughened or corrugated to afford a foothold for the men. Such floors are more apt to be found in shops or manufacturing establishments, sometimes consisting of cast iron plates or of steel or wrought iron sheets. Sometimes metal plates are used on concrete floors to provide runways for heavy trucks. At the Pennsylvania's transfer station in Pitcairn yard the platforms have a surface of 1 in. by 6 in. oak (not tongued and grooved), with sheet iron covering in the runways where trucking is severe. This makes a very satisfactory floor and is easily repaired because broken pieces can be replaced without disturbing the remainder of the floor.

C. Wood Block Floors

A wood block floor is one in which the wearing surface consists of small blocks so laid that the grain of the wood is at right angles to the floor surface. In order to insure a satisfactory wood block floor, a good concrete or other solid and substantial foundation is necessary. This type of floor is resilient, smooth, easy for trucking, readily repaired, dustless, has long life and entails a low maintainance cost. It will not, however, stand exposure to weather, and, as a general rule, repairs leave an uneven surface. Wood block floors are divided into two classes: Untreated and Creosoted.

(a) Untreated Floors.

Untreated wood block floors can be used to advantage where delicate merchandise is handled. The blocks should be placed on a ¾ in. or 1 in. sand cushion and the joints filled with 1 to 1 cement mortar or laid on a pitch base and the joints filled with asphalt. The sand or pitch acts as a cushion for the blocks and insures an easy working floor. Care should be taken that this floor is not exposed to the weather, as water may cause it to buckle. On the westbound platform of the St. Johns Park freight station of the New York Central in New York City, there is an untreated wood block floor with pitch joints on the sand cushion, which has been in service over 25 years. This floor has given excellent service, with practically no maintenance, and its age is not indicated, inasmuch as the blocks are still sound, except that at doorways the edges have been worn and several depressed areas appear. This floor has been subjected to exceptionally hard usage and speaks well for this type of floor.

Floors of this type are easily repaired by removing worn or damaged blocks and replacing them with new material. However, when such repairs are made it produces a very uneven wearing surface which, at times, might have a tendency to damage fragile merchandise or packages in trucking.

(b) Creosoted Wood Block Floors.

Floors of this type are laid similarly to the untreated wood block floors and have practically the same characteristics. They have been installed for 10 years or more, and are giving exceptional service. The main objection to creosoted wood blocks in freight stations is that the creosote taints certain kinds of merchandise, such as flour, butter, etc. At points where these commodities are not handled, it is considered an ideal floor. Blocks should be especially treated for interior use inasmuch as paving blocks for street use have proven unsatisfactory. Trouble has been caused from time to time by shrinkage and expansion, and it is recommended that in dry locations blocks should be well seasoned, while green or semi-air dried blocks are preferable for damp or moist conditions.

Repairs are easily made the same as for untreated wood block floors. The City of New York made repairs to the creosoted wood block pavement on the East River bridge after 2 years' service and came to the conclusion that the 4 in. block formerly used was too heavy

and that failures in sub-floors occurred before the blocks were properly worn down. For this reason, the size of the blocks was reduced to 2¼ in. It was also discovered that the bituminous filler or pitch was affected by the creosote, so that the joints would not set up well and on the new work the blocks are placed directly upon a yellow pine subfloor without cushion or filler. It was thought that if sand was used it would eventually work through the unmatched planking and leave an uneven finish on the roadway.

Wood Block Floor, B & O. R. R.

The Baltimore and Ohio installed a wood block floor in its in-bound freight house at Washington, D. C., in 1910. The floor is 50 ft. wide and 800 ft. long, of wood blocks on a sand fill; well rammed. It was laid with a crown of 3½ in. and has given perfect satisfaction, no repairs having been required except in two places where the floor had been undermined by rats. The accompanying photograph taken on September 16, 1920, is typical of the entire floor. A large volume of l. c. l. freight of all classes of commodities is handled over this floor daily.

Patented Wood Block Floors

When the idea of using the end grain of the wood for a wearing surface was first introduced it was thought that the big problem in connection with freight house floors had been solved, but it was found that there was still more or less difficulty because the blocks would not "stay laid." Floors that at first seemed to give eminent satisfaction did not continue so and it was evident that some way must be devised to anchor the blocks. This has been done in a patented type of flooring in which the blocks are dovetailed to a base and manufactured in strips of flooring lengths so that they can be laid like a matched floor, except that the tongues or splines are loose. The unit of flooring is toenailed through the base to sleepers imbedded in concrete, as is usually done with wood floors on a concrete foundation. In the case of a concrete floor that has gone to pieces the procedure would be to surface up the concrete, lay strips on it close together and laying the patent flooring on these strips, thus making a large mat floor.

This type of floor has been used for only four years but has already demonstrated its efficiency in various railway installations It has

been subjected to the most exacting conditions and no complaints have yet been heard. It is a well-known fact that no truck with metal wheels will go smoothly over floors because metal wheels are not made carefully enough, and it is therefore necessary to provide a floor that will withstand such trucking. This patented type of floor appears to meet the condition and may be said to "talk back" to the trucks, but it must be remembered that in this, as in all other types of freight house floors the foundation must be properly prepared. The subject of foundations is mentioned in this connection because it has a large bearing on maintenance, it being well known that the same floor with a good foundation will render longer and better service than one with a poor foundation, and also that when a floor with a poor foundation requires renewal, it is necessary to rebuild the foundation, thus incurring additional maintenance expense. This patented type of flooring is manufactured entirely from long leaf yellow pine, the effectiveness of which is well known, and laboratory tests have proved it to be an excellent wearing material. Floors of this type are easily taken up and relaid because of their style of construction.

D. Brick Floors

Brick floors do not seem to be desirable floors for freight houses. The general opinion among railroads as to this type of floor seems to bear out the following facts, viz.: it is a strong, durable floor with a low maintenance cost, easily cleaned and sanitary, but it is not adapted to easy trucking, is a hardship on the truckers' legs and feet, and is very noisy. It is brittle, so that it chips and breaks easily, and is unyielding, so that falling packages of delicate or fragile character are often damaged. Brick floors are recommended for storage warehouses or freight houses which are subject to damp conditions and for the storage of oils, paints, greases and other volatile and inflammable materials on account of the fire-resisting qualities of the brick. Brick floors should have a good concrete foundation with a sand cushion as shown by Fig. E.

The Delaware, Lackawanna & Western has a freight house in Utica, N. Y., where a brick floor has been in service for about 15 years, with practically no maintenance, and is still in good condition. The Missouri Pacific has used a brick floor in its Wichita freight station for about 6 years and to date it has shown little wear. Truckers at this station report this floor as being satisfactory as far as they are concerned. The New York Central has had a brick floor on a cinder foundation in use for about 7 years in its warehouse at Ohio Street, Buffalo, N. Y., and except for chipping and cracking around the doorways it is in good condition. Attention is called to the use of vitrified brick pavement on the platforms in connection with the warehouses of The New York Dock Company, Brooklyn, N. Y. This brick pavement is laid on a concrete base and after a service of about 7 years, it shows no sign of wear.

In the large concrete store house at the Greenville shops of the Bessemer and Lake Erie a brick floor was laid on a slag fill and has given very satisfactory results under heavy trucking. It is easily maintained at low cost, as the brick are merely sand filled and slight depressions can be raised readily without disturbing the balance of the floor.

Repairs to brick floors are very easily made by taking out the defective bricks and replacing them with new ones, care being taken to see that the sand cushion underneath is compact and level and thus make the floor surface as smooth and even as possible. Sometimes it may be found necessary to remove and relay more or less of the surrounding floor in order to insure a good job.

E. Asphalt Floors

(a) Asphalt Mastic Floors

Opinions on this type of floor show a great deal of divergence. Theoretically it should make an ideal floor, but this is not always borne out in actual experience. The manufacturers of this flooring material contend that it is an ideal floor when properly laid for shops and freight houses, floors of this material being in service after 25 years of use and abuse. They further claim this material will outwear other floors several times, is easy to walk and truck over, becomes denser under heavier traffic, will not wear uneven, crack or disintegrate, is noiseless, dustless and easily cleaned, is sanitary, waterproof and fire-resisting, and above all, is easily repaired. Workmen comment that the mastic floors are non-slippery in dry weather but are not in great favor due to excessive wear on shoes, which is about 100 per cent more than on wooden floors.

Experiences of several roads are given below with varying opinions as to merits of this type of flooring.

The Grand Trunk has used with reasonable success, a 1½ in. or 2 in. mastic over a concrete base well troweled, but not hard enough to destroy its elasticity. Varying temperature has its evil effects and they emphasize the importance of selecting material which withstands temperature changes.

The Michigan Central placed a mastic floor in its Chicago outbound freight house in 1912, but it was found entirely too soft even for light trucking and was quickly replaced with some other material.

The Illinois Central has floors of mastic at Mattoon, Ill., and Memphis, Tenn. Under ordinary conditions they give good service, but when sudden temperature changes occur they become damp and slippery from condensation and have caused considerable complaint and adverse comment.

The New York Central has obtained good results with this type of floor, but there are occasional indications of wrinkles and wave flow. Its service in dry buildings or localities is both durable and economical, but in damp weather, the floor has a tendency to become sticky and slippery.

The Chicago & Northwestern has several mastic freight house floors which have been in service 8 or 10 years and are in first-class condition.

Floors of asphalt or mastic are probably more easily repaired than any other kind. If a hollow place or hole develops it is repaired by removing enough of the top layer until all of the surrounding surface is on a level plane. New asphalt or mastic is then applied and finished as in the original floor. There seems to be no difficulty in securing a good bond in this case because the material is applied in a fluid or semi-fluid state, usually hot. Should mastic flooring be damaged by accident or by loading on points, a perfect and invisible patch can be made over the spot so injured, repairs being made over night and not being detectable after a short time. As soon as mastic floors become worn in certain parts more material can be added and the floor brought up to its original thickness.

(b) Asphalt Block Floors

Asphalt block for freight house floors has only recently come into use and very little data are available regarding them. The manufacturers claim for them a life of thirty years. The blocks are laid like wood blocks, or brick, in a mortar bed on a concrete base. No expansion joints are needed and the floors will stay smooth without heaving. The wear is slow and, it is claimed, no chipping or spawling will occur. It forms a floor which is noiseless, dustless, waterproof, odorless and sanitary.

The asphalt block type of flooring and paving is an outgrowth of the old sheet asphalt or mastic. In laying a floor of asphalt blocks there appears one item of paramount importance and that is the ease and simplicity of maintenance or repair and incidentally low cost. The blocks come absolutely uniform in size, composition and density and are all ready to lay up with ordinary labor. There is no need of any messy equipment or tools other than a 4-lb. hammer and a mason's chisel. There are no expansion joints to think about as the blocks will never swell or buckle. Just dampen enough sand and cement to strike a smooth bed over the concrete and then proceed to lay the asphalt blocks thereon in the usual manner. Being pressed to uniform size,

Asphalt

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in summer weather
of asphalt blocks. The element of chance is eliminated entirely. The blocks are perfect in composition and each block is given a compression of 200 tons in great mechanical presses.

Asphalt blocks are manufactured in two popular standard sizes in the United States and Canada. The first size is 4 in. by 8 in. by 1¼ in. (thick) and the second size is 5 in. by 12 in. by 2 in. (thick). An extra heavy block 2½ in. thick is also made but it seldom happens that conditions are extreme enough to warrant the use of this size. The modern asphalt block originated in 1880. The block type of asphalt flooring and paving represents asphalt in its very highest development. By thus eliminating the objections incidental to the old "sheet" type of installation, we secure the ideal floor for freight houses, platforms and railroad shops. No usage is too severe for an asphalt block surface—indoors or out of doors—in any kind of weather. It is a permanent institution. Floors of this type are fireproof, clean, dry, odorless, non-absorbent and sanitary. The blocks are restful under foot and can be trucked over in the hottest weather easily and with no indentation of

the material. Asphalt block floors are never slippery and will not sweat and retain moisture as is sometimes the case with "sheet" installations. The improved asphalt block is a trifle more resilient than was originally the case. This nicety of balance was arrived at by watching the performance of asphalt block installations over a period of years. The standard asphalt block is now practically wear-proof and will iron out perfectly smooth and remain so. Asphalt blocks can be produced to meet any desired degree of malleability.

Repairs are easily made. If it should ever be found necessary to take up some of the old blocks and re-lay them bottom side up or substitute some new ones, there will be no resulting unevenness whatever in the surface of the floor. A slight adjustment of the ½-in. bed on which the blocks are laid will take care of this contingency. These floors are even and attractive when newly laid and get smoother still with continued usage. A hundred installations will be found to prove this where one can be found to indicate the reverse—a tendency to

Asphalt Block Floor. Outbound Freight House, N. Y. C. R. R., Cleveland, Ohio (Extra Heavy Trucking)

cobble slightly at the joints. Upon investigation, these isolated cases prove to be the result of a loose and careless installation of the blocks, a factor against which the manufacturers can not always protect themselves. The leading block makers, however, usually make it a point to coöperate in the installation in some fashion where experienced supervision is lacking. Where the job is sufficiently large and close at hand, a complete installed price is sometimes submitted but the owners usually find it cheaper and just as satisfactory to handle the operation themselves.

Many of the earlier asphalt block floors in this country are in excellent condition today after 25 yrs. of the hardest usage. Notable among these are the Westinghouse Electric & Manufacturing Company, in East Pittsburgh, Pa., and the Morgan Engineering Works at Alliance, Ohio. A majority of the great railroad and steamship piers and ware-

houses on the Atlantic Seaboard, including the large U. S. Army and Navy Bases, are paved with asphalt blocks inside and out. It is in freight house, pier and platform installations such as these the asphalt block appears to have met with its greatest success although heavy machine shop floors run a close second owing to extreme durability and ease of up-keep. The new Union Station at Indianapolis has asphalt blocks on the upper level passenger platforms as well as the freight and baggage platforms below. A recent inspection of this work showed that the installations were in excellent condition and apparently good for the life of the structure. The engineers and architects indicated that they were unusually well pleased. Geo. T. Hand, Chief Engineer of the Lehigh Valley, also conducted a thorough investigation of this material and then specified asphalt blocks for the Lehigh Valley machine shops at Ashmore. Mr. Hand was also consulting engineer for the large Lamport & Holt Steamship Piers at Hoboken which are also paved with compressed asphalt blocks. The New York Central Railroad has about 150,000 sq. ft. of asphalt blocks around the Grand Central station in New York City. They have also a large quantity in their new freight terminal in Cleveland. It is quite likely that they will eventually re-surface the balance of this freight house with asphalt blocks also, specifying, however, a slightly softer or more malleable block than was furnished on the original work. The block manufacturers have advised this for any more interior installations especially. W. E. Phelps, assistant engineer for the New York Central at Cleveland was responsible for the introduction of asphalt block on this particular operation and has gone into the flooring question most thoroughly. The Atlantic Coast Lines; Delaware, Lackawanna & Western; Alabama Great Southern; New Orleans & North Eastern; New York, New Haven & Hartford and the Indianapolis Union Railway in conjunction with the Pennsylvania System are using asphalt blocks for freight house and shop floors extensively.

F. Concrete Floors

This type of floor is cheap and fairly permanent, is sanitary, easy to clean and requires no special foundation. Two suggestions for concrete floor installation are shown in the illustrations. It is becoming a general practice of late to reinforce concrete floors, but this does not add materially to their life except on filled or new-made ground where it might afford some advantages. A concrete floor, as a rule, is dusty, noisy, hard on truckers' legs and feet, is easily damaged by falling packages and merchandise, becomes soft and worn in spots, which eventually develop into large holes and uneven surfaces, is subject to surface cracks due to temperature changes, and breaks up under the impact of truck wheels. For these reasons the maintenance cost is high and this type of floor does not compare favorably with other floors. Great care should be exercised in laying concrete floors so as to overcome the above disadvantages and difficulties as much as possible.

The reinforcement of the top of a concrete floor with triangular mesh will tend to harden the top surface and prevent hair and seasoning cracks, and thus prolong the life of the wearing surface. Extension cracks cannot be altogether avoided, but when they first occur, as they will in cold weather, they should be filled up with a heavy composition similar to what is now being used on concrete highways.

Methods to remedy the tendency of concrete floors to crack, dust and disintegrate have been the subject of much study, and a large number of patented methods and devices such as surface hardeners, etc., have been marketed with varying success. It has been found by years of experience, not only in railroad shops, freight terminals, etc., but also in industrial plants of all classifications, that the wearing qualities of a concrete floor depend principally on the coarse aggregate used and on the method of working and mixing the materials. In other

words, workmanship counts more than anything else when a good concrete floor is desired, based on specifications adapted to the particular installation with a great exercise of care in the selection of materials during construction. It seems to be generally accepted that an excess of water in mixing, which allows the clay in the cement to rise to the surface, is the principal cause of dusting. Excessive troweling on the finished process is also inadvisable.

The Missouri Pacific used this type of floor to a considerable extent but without much success. The D. L. & W. used a 4½ in. rough concrete base with a 1½ in. finish surfacing. It was found objectionable on account of spawling, which made it hard for trucking, and it was also found that sudden changes in temperature caused condensation, particularly affecting flour and other similar merchandise. The Central Railroad of New Jersey experiences similar trouble from spawling, particularly at joints, where repairs have been numerous, but do not last long. A short time ago the New York Central laid an experimental floor at Black Rock freight station, Buffalo. It was laid in 8 ft. by 8 ft. squares with expansion joints. The floor proved to be a failure and was condemned by the engineer of maintenance of way. The same type has been tried at several other points with similar unsatisfactory results. The great trouble experienced seems to be in maintaining as repairs are not lasting.

On the Erie the concrete floors that were first installed gave much trouble, the truck wheels chipping off the concrete at the joints. On new concrete floors that are now being put in, edgers are not used at the joints and no top or finish course is put on. Class A concrete is used, composed of one part cement, two parts sand and four parts of stone, all put in at one time. A home-made tool is used to tamp the stone in the concrete so that it can be floated. This consists of a wooden block with a handle, in the bottom of which 10d wire finishing nails are driven, spaced 1 in. apart and projecting two inches. Three-ply strips of roofing paper cut to proper width are used for expansion at the joints and no edgers are used. This results in a smooth floor that does not chip off at the joints. The same method of construction is used on all cement sidewalks and station platforms.

When a concrete floor develops holes as noted above, repairs may be made in one of two ways. It may be patched by first cutting away and removing all of the loose or poor concrete until the edges and bottom of the hole are of good sound concrete and this hole filled with new concrete. This method, however, usually turns out to be only temporary because it seems almost impossible to get a good bond between the new and the old concrete and another hole will soon develop. The old concrete seems to have absorbed sufficient foreign matter or dirt of a more or less greasy nature to prevent a good bond. The better way is to take out the entire square or slab of concrete and replace with new material.

General

It is suggested that in the design of large freight houses it might be desirable and practicable definitely to lay out aisles or trucking spaces on which the better and more expensive flooring should be laid, allowing the use of cheaper materials in spaces used for storage and on which very little or no trucking is likely to be done.

Standard drawings of eight different types of floor of the Pennsylvania System are herewith reproduced as information.

J. P. Gallagher, N. Y. C.
D. Rounseville, C. & N. W.
A. T. Hawk, C. R. I. & P.
C. P. Rawson, C. M. & St. P.
T. D. McMahon, Great Nor.
C. J. Scribner, C. B. & Q.
D. L. McKee, P. & L. E.
S. C. Tanner, B. & O.
F. H. Soothill, Ill. Cent.
Committee.

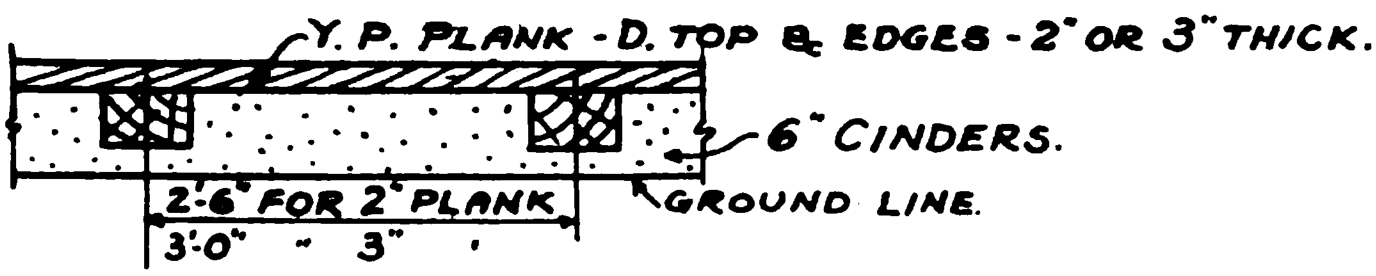


FIG. C.
YELLOW PINE ON
SLEEPERS ON GROUND.

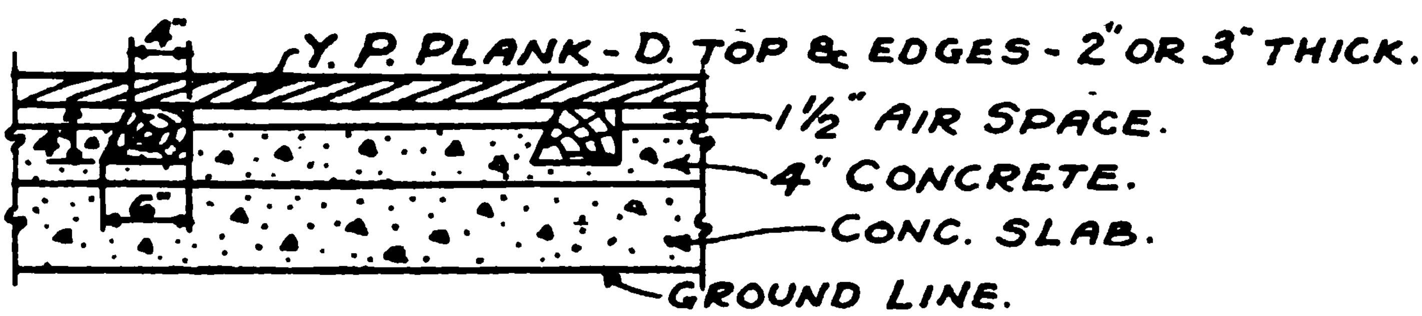


FIG. D.
YELLOW PINE ON SLEEPERS
ON CONCRETE ON GROUND.

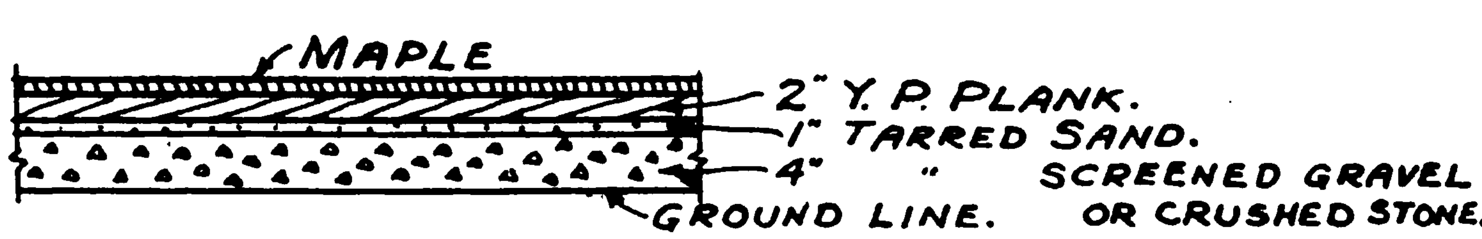


FIG. E
MAPLE WEARING SURFACE ON
PLANK ON TARRED SAND & GRAVEL.

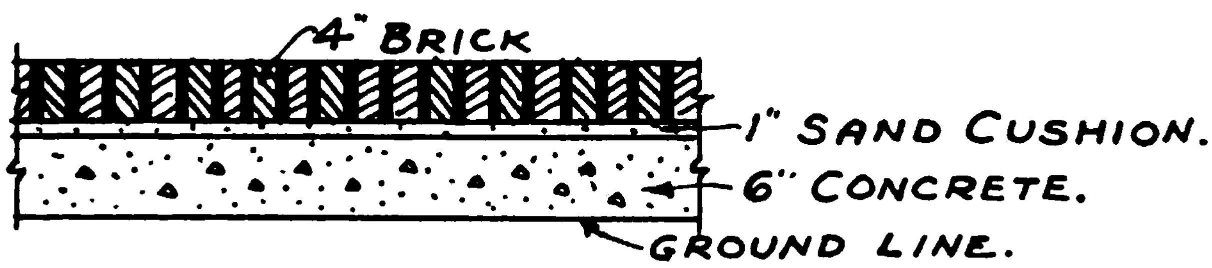


FIG. F.
BRICK ON CONCRETE
ON GROUND.

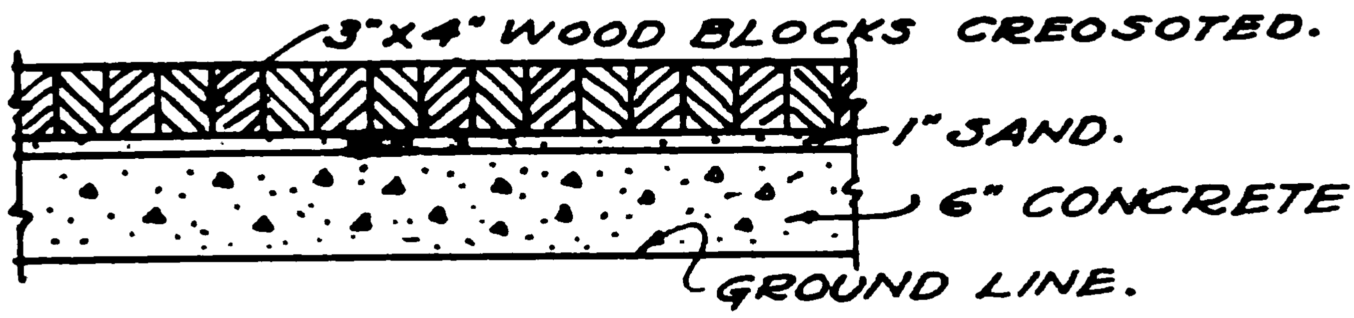


FIG. G.

CREOSOTED WOOD BLOCKS
ON CONCRETE ON GROUND.

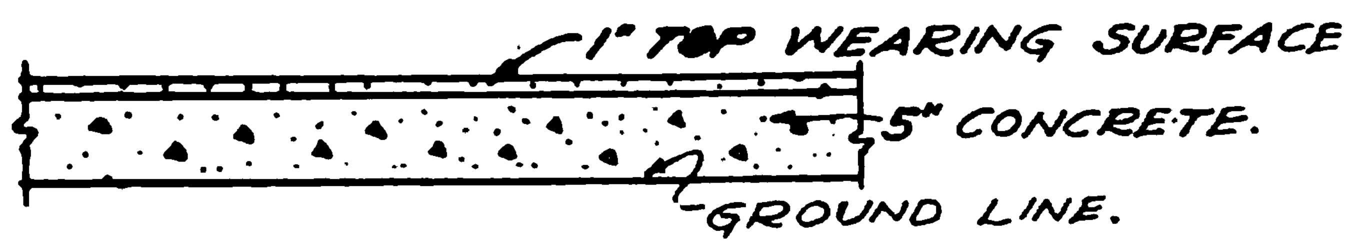


FIG H.

CONCRETE ON GROUND.

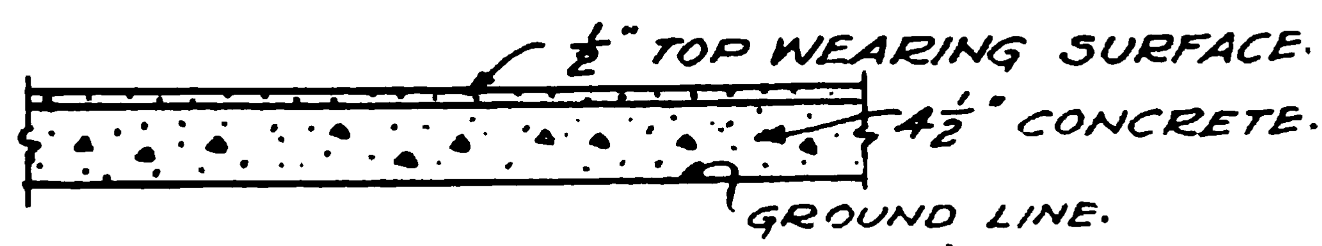


FIG. I.

CONCRETE ON GROUND.

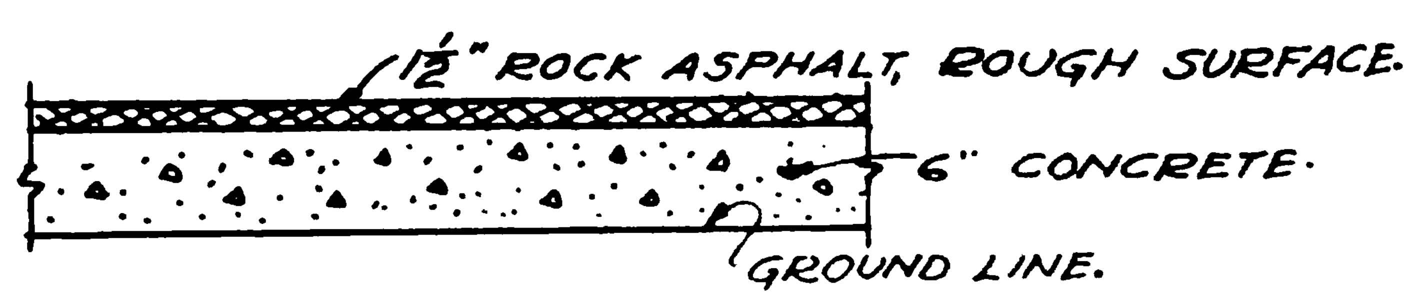


FIG. J

ASPHALT ON CONCRETE ON GROUND.

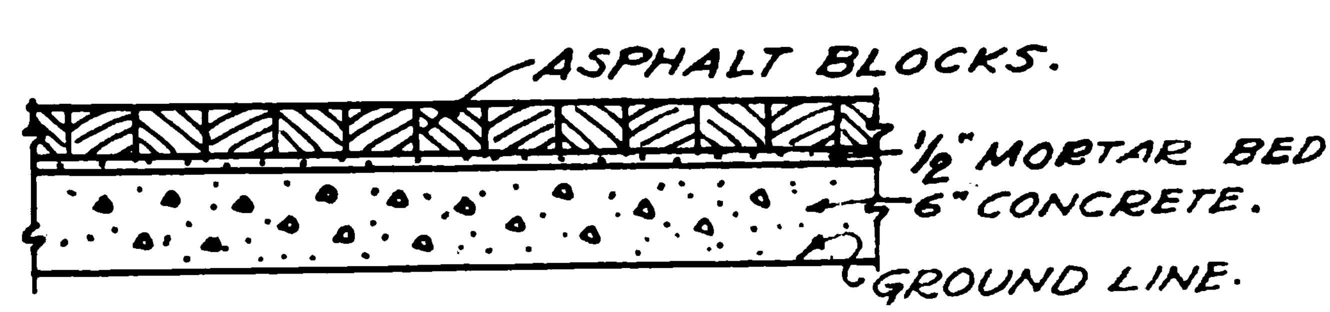
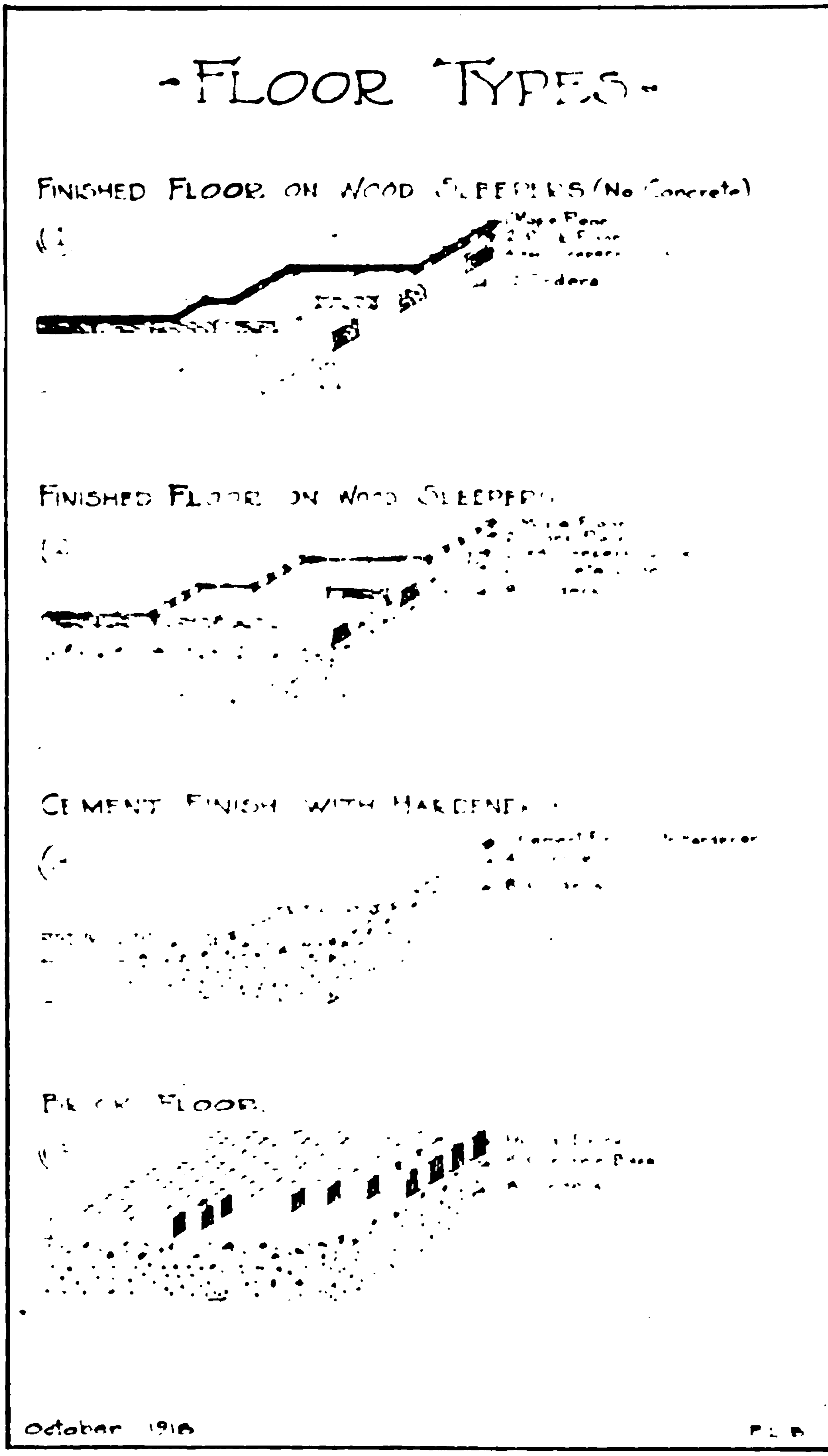
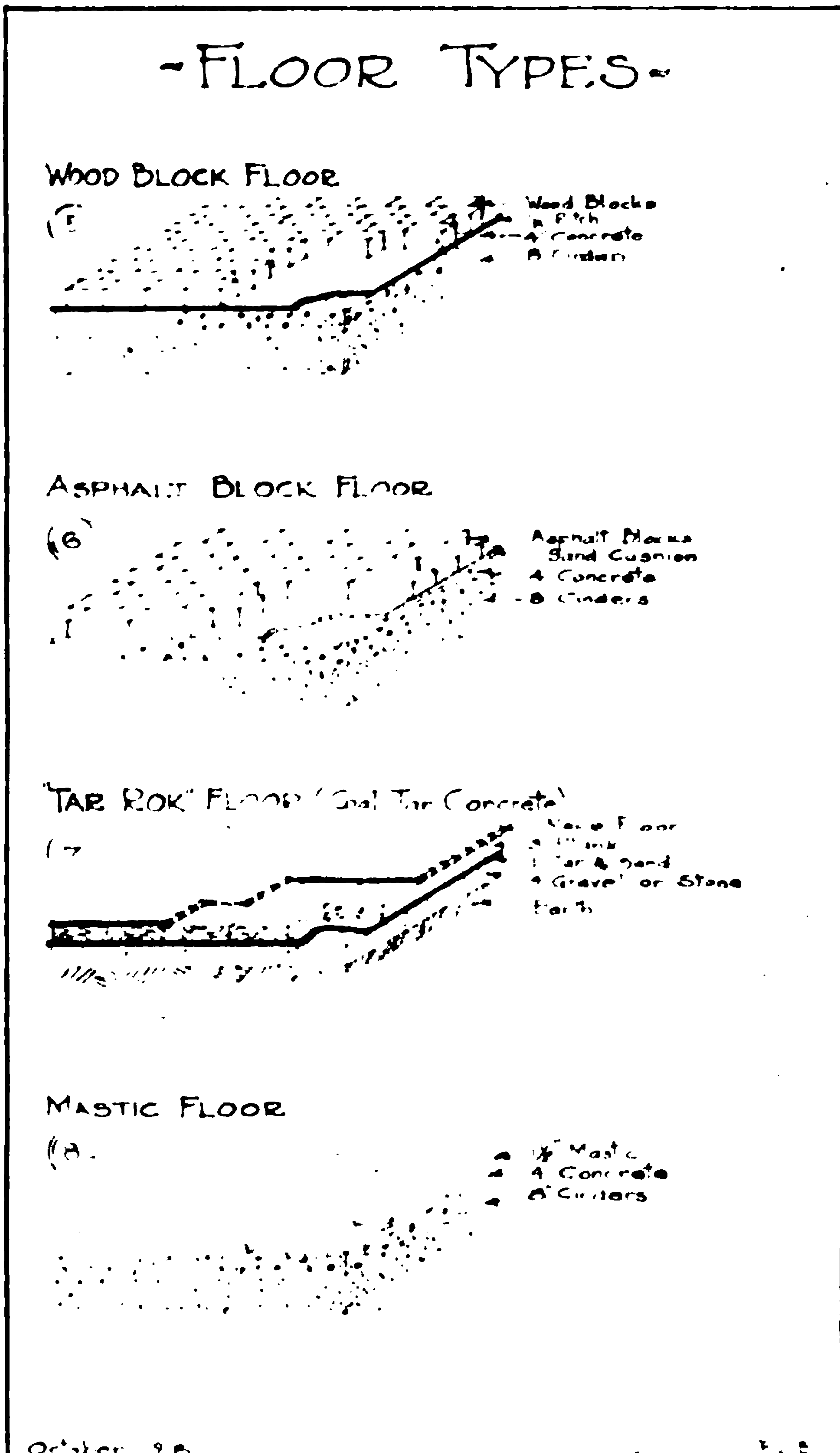


FIG. K.

ASPHALT BLOCKS ON CONCRETE
ON GROUND.



Floor Types, Pennsylvania R. R.



Floor Types, Pennsylvania R. R.

(DISCUSSION)

(Repair and Maintenance of Freight House Floors)

President Weise:—The first part of the subject pertains to wood floors. They are of two types. One is the ordinary floor of 2 in. or 3 in. plank laid on stringers or floor sills; the other is in a measure a built-up floor with a hard wood surface, and let us take that up first. Those of you that are interested in floors have probably had time to read over this report and can give us something of your experience that will add to it. Next comes the subject of wood floors covered with metal plates. Have you any such and if so are they working out satisfactorily or are they causing you trouble? Do you have any trouble with the plates buckling? Do men have difficulty in walking on the metal plates?

A. S. Clopton:—We have such a platform in Kansas about 1,000 ft. long that has been down seven years and is very satisfactory. It is laid over 2-in. decking and is very satisfactory in handling the large amount of freight which we have there.

President Weise:—The next class is wood block floors, which ought to be quite interesting. Perhaps Mr. Tanner can tell us something about some of the wood block floors he has installed on the Baltimore & Ohio.

S. C. Tanner:—We have had the best success with wood block floors laid on a concrete base, but we have one in Washington which was laid on a sand fill which has been in service for 10 years and is in good condition yet. No repairs have been necessary to keep this floor in good condition excepting in one place where it was undermined by rats. The wearing surface has remained very even and in good condition. I feel that wood block floors are about the best that can be used for freight houses.

President Weise:—One point I would like to emphasize is that strips to be imbedded in concrete should be creosoted in order to prevent decay. If no one else has anything to say on wood block floors, let us next consider brick floors. Has anyone anything to offer that is not covered in the committee report? This portion of the report has been covered pretty thoroughly and is good information. Then let us take up asphalt floors, of which there are two kinds,—asphalt mastic floors laid in one sheet, and asphalt block floors.

Secretary Lichty:—There are quite a good many here who were at the convention last year at Cleveland. If you remember,

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future. We must have in mind not only the cost and the facility with which we can build our structures, but we must bear in mind the difficulties we are going to have to maintain floors and the length of service we are going to get out of the various kinds of materials.

FILLING BRIDGES—MAINTENANCE OF STRUCTURE DURING FILLING

REPORT OF COMMITTEE

When construction work on a new line of railroad is begun every possible effort is made to expedite the laying of the track in order to permit the operation of work trains for the handling of men and materials, thereby hastening other construction work, and also to permit the operation of revenue trains. In order to accomplish this more quickly waterways, ravines and various depressions are crossed by means of timber trestles, which are then used as long as they can be maintained economically. The timber trestle has the advantage that it can be built quickly and time is available during its life to enable a study of the situation to be made in order to determine the type of permanent structure that should be built for the necessary waterway or other opening. Wherever possible, timber trestles are replaced by earth embankments because this forms the most efficient roadbed. Thus it is that almost all railroads have programs of bridge filling each year, and it is of interest in this connection to note how the total length of bridges of this character is gradually reduced from year to year.

Your committee has endeavored to canvass the methods of filling the larger and higher trestles because these are the most difficult to care for and maintain in safe condition for the operation of trains during the progress of the filling. It is sometimes possible to begin the filling within a year or two after the pile or timber trestle is first built by putting in from 18 to 24 in. of earth in ravines each year, thereby gradually filling the opening and also serving the further purpose of preserving the piling, which rots at the ground line, by carrying this line a few feet higher up on the pile each year before decay has had time to injure it. When this method can be followed the structure will not be disturbed during the process and no extra precautions need to be taken.

In cases where the filling must be done more rapidly, it is necessary to take precautions to see that the bridge structure is at all times safe for the operation of trains. Before the filling is begun the structure should be gone over carefully and, if necessary, strengthened, and as many of the longitudinal members as can be spared should be removed as the work progresses, as they are in the way of filling material. As the filling material is placed, it should be spread uniformly around and under all parts of the structure and compacted as thoroughly and evenly as may be between the trestle bents to avoid crowding them out of line. It has been recommended that, as this material is spread, the outer edges should be kept higher than the center to prevent the washing of the slopes, and also to aid in the settlement of the filling, but whether this need be done or not will depend largely upon the nature of the filling material. The material used for filling may have much to do with the progress of the work; in some cases it may be best to fill the trestle partly and allow several months to elapse for the settlement of this portion before proceeding with the balance.

There are various methods of filling bridges and the one to be used will depend upon local conditions, such as the topography at the bridge site and the accessibility of suitable filling material. The best kind of filling material is that which will pack solidly, is not liable to slip or slide and will not wash away easily during heavy rains. The distance from the bridge to the location of suitable filling material will largely

the job more difficult and increasing its cost. This is true whether the bridge is high or low. When filling is begun the sway braces should be removed from the bents and as the dirt is deposited men should be on hand to cast it around the piles or bents in order to keep the bridge from crowding out of line. On high bridges the lower sway braces and horizontal braces should first be removed to enable teams to drag the dirt between the piles or posts. As the filling progresses the higher braces are taken out as fast as they interfere with team movement. When the filling is done with steam shovel it is best to distribute the dirt with men and teams as above except in cases where the steam shovel is located near by and the dirt trains come in so rapidly that there is insufficient time between trains.

The filling of a high bridge can be made better by having one or two water cars with several outlets pass over the bridge after the dumping of each train load, thoroughly wetting the dirt, causing it to settle more quickly and avoiding later bad effects. When filling with steam shovel and dirt cars is begun, every alternate trestle tie should be removed, permitting the dirt to be distributed more easily in the center of the bridge. As the filling nears the top the guard rails are taken out and a temporary guard rail is provided by spiking a 2 in. by 6 in. or 2 in. by 8 in. timber on the ends of the ties, thus holding them in place. This is done to permit the use of a spreader that will not clear the ordinary 6 in. by 8 in. guard rail. In filling high bridges with steam shovel material it is important that a good class of earth be selected, avoiding such as will not pack readily or such as contains quicksand or slides when wet. The best material is secured from shale or clay banks.

After the filling has been completed the writer believes that the stringers should be removed immediately, although many think best to permit the fill to stand for several months or perhaps one or two years to allow for settlement. In my opinion no matter how long the fill stands there will be a slow piece of track at this point for some time after the stringers are taken out, and my experience indicates that the sooner the timbers are removed the sooner the track will get into good condition.

Several plans may be used successfully to remove the stringers. One of the best is to pull the chords with a derrick, employing the following or similar methods: When ready to remove the stringers on a long fill, first deliver the requisite number of track ties and spikes on the ground. Use one gang of from 8 to 12 bridgemen and another of from 20 to 30 track men or more if the job is a big one. The chords should then be cut into sections of 60 to 75 ft. The track is then lifted from one section, all of the bridge ties removed and the derrick line secured to one end of the chord, raising it about 6 ft. The chord is then dragged by a work train to a point where it is convenient to remove the bolts and load the material. After both sections of the chord have been dragged out in this manner all available men are used to cast dirt in the space, filling it to the required height, which should be at least 6 in. above the original track level. The track ties are then placed and tamped with shovels. This plan of operation is then repeated on the next and following sections. After all of the stringers are removed the track at each end should be raised on dirt from 6 to 12 in. above the original level and the bank dressed off to prevent damage from heavy rains. The track at this point should be carried on dirt for several months if possible and cinders or other ballast should not be placed on the bank until several soaking rains have fallen on it. In most cases it is necessary to protect the section of track with the usual slow orders and flags and sometimes a watchman should also be employed constantly. The track foreman should visit the place daily until the track is in safe condition.

When a derrick is not available for pulling the stringers or on short bridges where it is not needed the best plan is to remove the chord bolts when the filling has reached a level at or near the bottom of the

stringers were removed and the filling settled about 6 ft. to 8 ft., the track being kept in proper surface by placing cinder ballast from time to time for a period of about 2 years. No trouble has been experienced during the past 4 or 5 years.

A bridge near Stoutsville, Mo., with a height of 59 ft. and a length of 294 ft. was filled in 1916 with a steam shovel, the material being sandy loam and soft sand rock. While the filling was being dumped in the bridge a 2 in. stream of water was kept flowing onto it almost continually, virtually puddling the dirt as it was placed; the stringers were removed immediately after the filling, and no trouble has been experienced since.

A frame trestle bridge near Stoutsville, Mo., with a height of 64 ft. and a length of 355 ft. was filled in 1918 with the same class of material as above (sandy loam) with a steam shovel. Some water was also deposited on the fill during the process of filling but not sufficient to properly puddle or settle it, which caused the fill to settle 2 ft. or 3 ft. The stringers were removed immediately and very little trouble has been experienced since.

A pile trestle bridge near Carney, Okla., with a height of 35 ft. and a length of 115 ft. was filled by teams October and November, 1919, with a red sandy soil. Immediately after filling the timbers were removed, and no trouble was experienced, trains operating over this fill on the original dirt filling at the usual speed.

On the Pennsylvania System

T. T. Lowdermilk, master carpenter on the Sunbury Division of the Pennsylvania System, describes several problems on that road as follows:—

Bridges and trestles under 50 ft. in height, can be filled from the center of the track, allowing the fill to run out each way. To keep down the cost of maintaining the structure while filling, bridges 50 ft. and over in height should be filled from the outside, allowing the filling to roll to the center of the spans of its own accord, keeping the fill on each side of the bridge to about a uniform height and of the same kind of filling. A very good way to make a fill of this kind, is to use side dump cars operated by air.

A wooden bridge on the Pennsylvania System, at Morea, Pa., of a height of 52 ft. and a length of 120 ft. was filled with mine rock and clay, using side dump cars and dumping on each side to a uniform height, allowing the fill to run to its own level to the center of the track. This bridge was filled without any interruption to traffic or any moving of the trestle work whatever and with no extra maintenance cost. The diagonal bracing was removed during the progress of filling, as was also all bracing that was liable to hold the fill, allowing the fill to bed itself.

During 1914 on the Pittsburgh Division, a bridge of steel construction, located at South Uniontown, was filled. This bridge was erected in 1900 with steel tower construction and girders. The height of this bridge was 110 ft., and the length 460 ft. The filling was of clay and rock to within 10 ft. of the base of rail, and the balance of the filling was cinders. This fill was made with dump cars and bridging built under bridge, throwing the fill at the bottom about 50 ft. from the center of the track at the start and allowing it to roll to the center by dropping the filling on each side. The solid packing of the fill was done outside of the towers. This steel structure was filled under traffic without any obstructions except pushing the track out of line about six inches.

On the C. M. & St. P.

The following methods employed on the western lines of the C. M. & St. P. are described by J. F. Pinson, District Engineer: Bridges are ordinarily filled by one of two methods. (1) If the filling material is secured from borrow pits near the bridge it is placed by teams and

about six months after the filling has been completed. However, we have had cases where bridges were filled with gravel and loose rock and stringers were removed within 30 days. The kind of material used for filling and local conditions such as rainfall, etc., will determine the length of time necessary before stringers should be removed.

The following is the experience of H. T. Potter, Chief Engineer of the **Bessemer and Lake Erie.** In filling a steel viaduct 86 ft. high, with material excavated from a clay and shale cut, it went out of line 3 ft. 10 in. at the worst place. We know that there was no settlement in this bent because the pedestals were a part of the side wall of a 26-ft. arch and there was no cracking or disturbance of the pedestals. We never came to any positive conclusion as to why these bents went so far out of line, but thought it was probably due to the fact that the afternoon sun on one side of the embankment caused the fill on one side to settle more rapidly than on the other side. This work was done in midwinter. After this we filled several viaducts from 80 to 90 ft. high and only used waste filling from the steel mills. These did not give us any trouble.

In filling a viaduct, with waste filling from the mills, at the north end of our Allegheny river bridge, which viaduct ran from 120 to 140 ft. high across the bottom, we were unable to unload the filling from the viaduct over which we operated on account of causing too much interference with traffic. We erected another viaduct along side it, on 32 ft. centers, out of steel from a viaduct which had been taken down on account of a change of line, and unloaded the filling from the temporary viaduct. The towers of the temporary viaduct were placed between the towers of the viaduct over which we operated, and in this way we were able to get the 32 ft. centers. The viaduct over which we operated, went out of line about one foot one day, so we had to stop the filling. We dug down to find out what the trouble was and it was found that the columns were made out of two 15 in. channels which were latticed and that the pressure of the fill had squeezed the two channels nearly together, the lattice work bulging out. We suspended filling for a year until the new bridge over the river was complete when we were able to use the temporary viaduct to run our trains over which allowed us to fill from the viaduct over which we formerly operated. In order to prevent the channels from squeezing together we drove in short pieces of 3-in. plank of the proper width at points where the top of the fill already made was still 50 ft. and over from the top of the viaduct. We were able to finish filling the viaduct without further trouble.

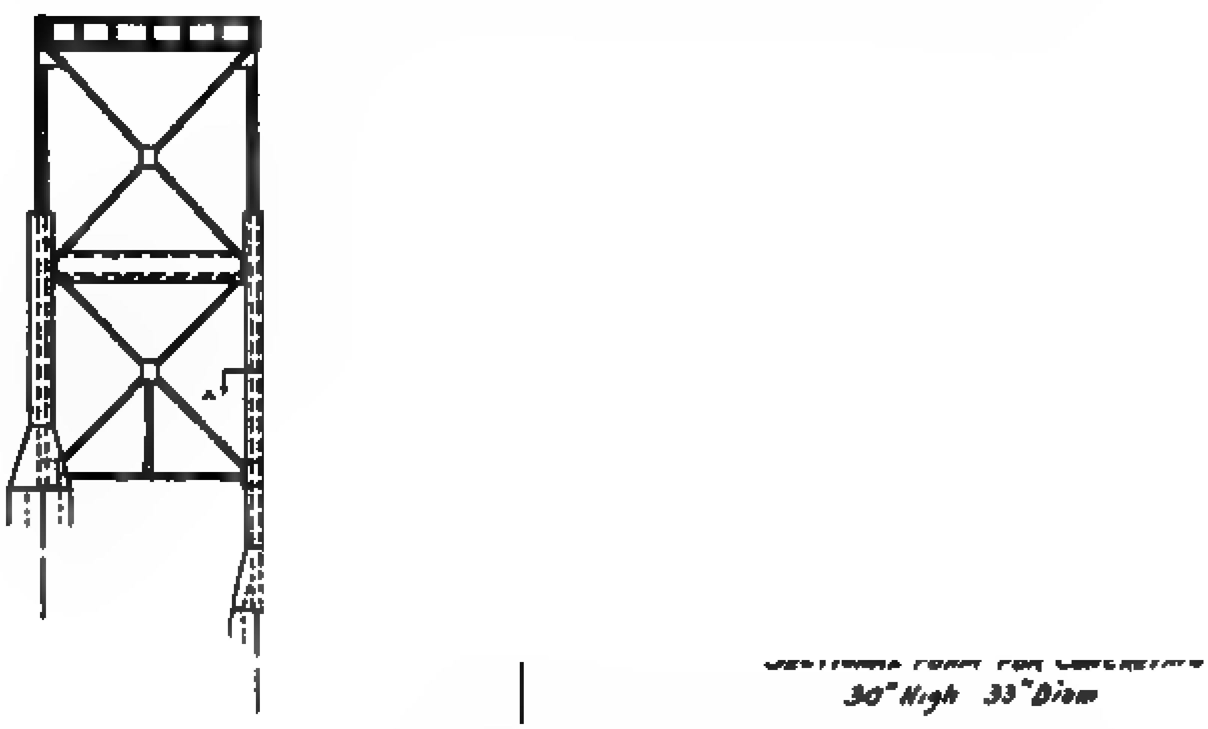
On the Philadelphia and Reading

A report of bridge filling now in progress on the Philadelphia and Reading, by Franklin Gable, Foreman Carpenter, follows:—

In the past we have repeatedly filled wooden trestles, ranging from 12 ft. to 40 ft. in height and experienced little or no trouble. Recently, in line with the general movement in equipping our lines with heavier power, it was decided to replace several steel viaducts on the Catawissa railroad with fills, providing culverts for the streams and roads. Five bridges were filled and abandoned: Dark Run viaduct, Stranger Hollow viaduct, Long Hollow viaduct, Mine Gap viaduct and Fishers viaduct. These viaducts were from 20 to 23 years old and built under specifications corresponding to Coopers E-40 loading. The general arrangement of bracing, etc., followed one type throughout. (See Fig. 3.) This is a single track railroad with heavy freight and coal traffic, the passenger service being limited. While it is possible to divert traffic to other routes on this division, this is only done at considerable loss so that it is almost imperative to maintain an uninterrupted train service. At first the filling of the bridges on this district was undertaken in much the same manner as was done in the case of the wooden trestles. A train of loaded cars was pulled on to the bridge and the doors released, allowing material to run from cars through the bridge floor.

746 ft. long between back walls and 129 ft. high. There were four Warren deck spans 85 ft. and one 75 ft. in length, and the remaining spans were of deck plate girders. The deck plate girder spans were at one end of the bridge and were supported on bents ranging from 23 to 40 ft. in height. The main truss spans were supported on steel towers as shown in Fig. No. 4.

A concrete arch culvert was provided for the stream. The work of placing this culvert was delayed and it was necessary to place a small portion of the fill while the work of concreting was still going on. However, the fill thus placed was not over 50 ft. high. The fill was carried to a uniform distance as measured from the base of rail until a height of 50 ft. was reached, the material being dumped from the cars in the



Reinforcing Columns during Filling, Mine Gap and Fishers Viaducts. Philadelphia & Reading R.R.

same manner as at Stranger Hollow and no attempt being made to spread the fill transversely, care being exercised to see that no large material was allowed to strike any of the steel work of the bridge. It is understood that normal traffic was allowed on the bridge, the only precaution taken being to maintain a slow order of 10 miles per hour. In March, 1919, when the fill had reached a height of 50 ft. (Fig. 5), it was noted that the bracing in the towers was showing signs of failure (Fig. 6), also at point "A" as shown in Fig. 4 the columns of the towers which was made up of two 15 in. channels latticed failed, going vertically out of line, the alternate lateral bars buckling (Figs. 7 and 8).

This necessitated placing bents at tower No. 2 from the north end where the failure occurred. Work was pushed rapidly. However, in March a later inspection showed that several other columns of the high towers were showing signs of bending. It was then decided that the safe thing to do was to erect timber bents to take the load from the steel work of all the high towers (Fig. 9) Traffic was prohibited from crossing the bridge during the time that these bents were being placed. After the bents were erected light engines and traffic were allowed. "V"-shaped inverted troughs were placed in all spans to spread the fill transversely. However, this method was not entirely effective. The wooden bents, on account of having a soft foundation on the new fill, frequently went out of line and it was necessary to follow the matter closely. However the filling was completed in November, 1919.

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sections to pass the bracing, the other side being filled out with laggings. The concrete mixer was located at one end of the bridge on top. A narrow gage track for a small concrete hopper truck extended the full length of the bridge, being carried on outriggers from the ties.

The sectional forms for the columns were placed for a height of approximately 20 ft. The concrete was carried from the mixer on a small hopper truck which dumped at the level of the track into a portable iron chute which in turn was zigzagged down the tower to the forms. The forms were allowed to remain on the concrete for one week before transferring them to the next tower. Handling the work in this manner, the time required to complete it was nine weeks, some delay being experienced on account of delayed shipments of material.

It is estimated that 240,000 cu. yd. of material will be dumped at Mine Gap. The cost per cubic yard of dumping this material was increased approximately five cents or about 16 per cent. To offset this there is the advantage of non-interference to traffic and the 16 per cent is a maximum, since the material can be dumped without delay on account of any work on the structure going on during the progress of the fill.

From the data and experience at hand, we are led to the conclusion that with only the ordinary easy precaution of maintaining a uniform longitudinal height, structures of this character less than 50 ft. in height can be filled without experiencing any considerable trouble. This may not hold true for pile trestles.

The character of the fill is an important consideration. The best results will no doubt be obtained by using uniform material. Industrial waste was used in filling the bridges referred to and gave rise to difficulty in unloading and also danger of the larger particles such as slag striking on the bracing when dropped. In the case particularly of ashes or cinders, precaution must be taken against fire, which may occur in either of two ways: (1) the fire may be in the cinders as dumped or (2) the unburnt material present may take fire in the fill through spontaneous combustion when dumped in quantity.

In this connection it may be well to make note of the Jordan bridge on the Catasauqua & Fogelsville railroad. In this instance the bank took fire, causing the collapse of the steel towers which supported a series of bridges crossing a valley 90 ft. below grade. This occasioned temporary trestling and considerable maintenance to permit traffic to be carried until the entire bridge was finished.

In greater heights than 50 ft. the fill should be maintained at a regular height longitudinally and also should be spread transversely for a distance well beyond the legs of the towers.

If possible all structures crossing the fill should be completed prior to beginning the filling in order that no deviation will be made in keeping the fill at a uniform height.

Due to the settlement and shrinkage in the fill which is considerable, the excessive weight brought on the bracing will cause it to fail and likewise cause a collapse of the columns. Therefore, it is necessary that the columns in all cases be strengthened and that the bracing, if possible, be supported or removed as the fill progresses and that stiff concrete or suitable longitudinal and transverse struts be provided. End filling should not be attempted on account of the longitudinal forces set up against the towers and also on account of the unequal pressure brought on the arches or culverts crossing underneath. In all cases a slow order of six miles per hour should be rigidly maintained in order to keep vibration at a minimum.

The practice on the **Duluth, South Shore & Atlantic** is described by G. A. Manthey, as follows: The usual method of filling high trestles if suitable material can be found near the job is to use small dump cars but if it has to be hauled any distance it is loaded on flat cars and unloaded with a plow. During 1913 and 1914 a bridge on the South Range Extension, Mineral Range Railroad, was filled. The bridge was 1,099 ft.

long and 62 ft. high and on a 2-deg. curve. The filling was done with flat cars and a steam shovel. Shortly after the filling was started, trouble was experienced with broken tower braces and the bridge went out of line. To overcome this, it was necessary to place an apron on the sides of the bridge, the top being flush with the ties. As the filling was unloaded heavy pieces were thrown out to clear the bracing. As the bridge had a tendency to travel with the curve, a side plow was used to keep the filling higher on the outside than on the inside of the curve. As the filling progressed a man with a horse and scraper was stationed at the bridge to keep the material leveled off under the bridge and to fill in around the plumb and batter posts. As the bridge was 13 years old some trouble was experienced with broken caps and sills. The caps were renewed and the sills covered deep with filling, a block was batted on the plumb and batter posts and a cross sill installed on the mud blocks. It was not found necessary to reinforce this trestle either before or during the work. To prevent lateral movement of the bents the sway and tower bracing was kept securely spiked, sash bracing was added where necessary, and these were all renewed if broken by falling material. The stringers on this bridge were removed two years after the completion of the filling.

F. Gable, P. & R., Chairman,
J. F. Pinson, C. M. & St. P.,
W. B. Harris, M. &. O.,
W. E. Burns, Sou. Pac.
G. A. Manthey, D. S. S. & A.,
R. J. Bruce, Mo. Pac.,
C. E. Smith,
A. S. Clopton, M. K. & T.,
Committee.

Addendum

(Information furnished after the Convention)

Since the above report was presented Mr. Gable has supplied the following interesting data in connection with the several bridges filled on the Philadelphia and Reading:

	No. cars filling	Cubic yards filling	No. working days	Average cu. yds. per working day
Dark Run	1,934	58,920	166	354.9
Stranger Hollow	4,844	143,285	437	327.8
Long Hollow	7,620	354,434	300	1,181.4
Mine Gap	4,193	125,790	170	739.9

The work of filling Mine Gap Viaduct, which at this time is about half done, is proceeding rapidly and satisfactorily. Up to this time there has been no sign of the bridge getting out of line or of the columns buckling and the method which has been explained fully in the committee report is proving very satisfactory.

DISCUSSION

(Filling Bridges)

President Weise:—I am quite sure that over 50 per cent of the members here have had considerable experience in filling bridges and you may be able to discuss this briefly in the next few minutes and give some of your experiences that will add to what the committee has prepared.

R. C. Young:—There is just one thing that I would like to call attention to that hasn't been mentioned in the report, and that is the use of a water jet. Where water is available I have installed a temporary pump and made use of a jet in distributing and settling the material around the bents. Not only is it a cheaper method of distributing it than any other I know of, but it gives the material the settlement that is necessary right away and a chance to distribute it in good shape. A pump that will develop 150 lb. pressure will do the work very nicely.

A. S. Clopton:—For the information of Mr. Young I will say that this method is mentioned in the fifth paragraph of the report given under the head of the M. K. & T. Ry.

(President Weise reads the paragraph.)

R. C. Young:—I had not noticed that.

President Weise:—We did not read that portion of the report, but those of you who are interested will find it profitable to read the entire report and then talk with some of the members of the committee.

F. Gable:—We have tried the method of using water to settle the filling around metal structures but it was considered a failure because of the high maintenance cost. It was rather a difficult problem and proved a waste of time with us.

In regard to the settling of the fill around the trestle bents of a steel structure of this kind, my experience has been when we had to place the trestle bents around a long fill we had, of course, to level the fill out a sufficient width to allow us to corduroy with bridge ties and it was so solid we had to use picks to dig it out and the buckling of the bents, especially on a long fill, started right on top of the fill each time. I think the buckling results not so much from the "push" but from the vibration. The reason that I am so positive of this is that after a heavy train had passed over this bridge the man in charge wired to the supervisor of tracks and myself to come there immediately

when we found a column buckling. I understand this train passed over the bridge at about 25 or 30 miles per hour. We examined the rest of the columns and found them all beginning to buckle right on top of the fill. As far as we went down in making this level space for the corduroying and settling of the bents there was no indication of buckling but it all occurred right on top of the fill. I claim, therefore, that the buckling is due to the vibration resulting from the speed of trains and with the solid settling around the bents.

President Weise:—Filling by the hydraulic or sluicing method has not been touched upon in the discussion. The committee report indicates that this manner of filling can be used only in rare instances where the location is such that the surrounding land is much higher than the track and where plenty of water is available, but it is said that there is no trouble on account of settling because the material packs compactly as it is washed down.

W. M. Camp:—The Southern Pacific has done a great deal of that.

R. C. Young:—I noticed that process used last summer quite successfully, where a penstock was being located for a hydroelectric line and it was done at a very reasonable cost. I did not get the figures, but it was not so expensive a method of transferring and compacting earthwork. This was a case where the bank was put up 22 ft. high with a slope of 1½ to 1.

RECLAMATION OF BRIDGE, BUILDING AND WATER SUPPLY MATERIALS

REPORT OF COMMITTEE

Changing conditions cause us to be constantly on the alert and we find ourselves frequently changing our points of view. This is nowhere revealed more forcibly than in our attitude toward the reclamation of building materials. That which was not worth the trouble of picking up a few years ago has so increased in value that it is very much worth while to spend considerable labor to reclaim it for further use. Your committee has endeavored to ascertain the extent to which various railroads have gone in this matter and presents its findings to you in a report that will bring out free discussion.

At first thought this seems to be more of a question for the store department, but the storekeeper must be governed by the needs of the man who uses material. The latter is also the one best qualified to say whether material he is recovering is fit for further use. Again, something depends upon how the material is taken out of the old structure. Therefore, this is a question of great importance to the members of this Association who use material, and whose experience enables them readily to determine its usefulness.

The reclamation of materials is not a new procedure by any means. It has always been the policy of railroads to make use of reclaimed or second hand material, but in the past this has been followed only with the larger things, until changed conditions, as noted above, have made it necessary to do it systematically and more definitely.

Following are some of the customs that were almost universally followed in the past: Bridge spans that, because of increases in the weight of rolling stock, have become too light for safe operation, are taken out and used on branch lines on which lighter power is operated or are used for highway bridges, where they give many years of good service. Locomotive turntables that are too short for modern locomotives are taken out at large terminals and installed at other places where shorter engines are handled. Culvert pipe taken out because of changed drainage conditions is put in at other points. Water tanks, stand pipes, wind mills, track scales and other structures that are taken down because they are no longer needed in those particular localities are stored until needed at new locations.

As stated above it is now necessary to go into the subject more thoroughly and it is of interest to note what the different railroads are doing. The results of our investigation are as follows:

On the **Chicago, Milwaukee and St. Paul** an effort is made to utilize all timber and lumber taken out of old structures to the best possible advantage. Bridge stringers that are too short for use in standard openings are resawed to sizes that will make sills for hand car houses, coal and oil houses, and out-buildings around smaller stations, and skids in the lumber yard. This material is given a treatment of carbolineum at the time it is resawed. Bridge ties are also resawed and pieces that are free from defects are used to make spacing blocks between ties on iron bridges while such as are defective are used in loading concrete pipe to prevent the sections of pipe from coming in contact with each other. Much of the above material is also used for car stakes. The rippings from the resawing are used to make crates for material that cannot be shipped open. The usable portions of brace plank are cut to lengths in multiples of two feet and are used in high-

shops at comparatively small cost, making them practically as good as new.

The **Ann Arbor** has for a number of years past been trying to salvage and make the best possible use of all material recovered from renewal and repair jobs. Material, when taken out of bridges is sorted, and all that can be re-used in temporary structures and retaining walls, for posts and caps for freight house platforms or similar work is loaded and shipped to the storekeeper as second class material and placed in stock for filling orders. Such bridge material as cannot be used for repair work is loaded and shipped to the store and sawed up for engine wood. Old bolts are either cut up for drift bolts or are sent to the shop to be rethreaded and refitted.

On the **Kansas City Southern** the engineering department gives close attention to salvaging second hand material and using it in repair work, in this way effecting a considerable saving and reducing waste to a minimum. When repairing or renewing pile or frame trestles all timber is salvaged that will answer for repairs to trestles, platforms, stock pens, etc. Stringers, caps, ties, posts or piles that are recovered are assembled and shipped to supply yards from which they are issued to repair gangs to replace similar material, leg up bents in old trestles, for retaining walls, for earth or gravel platforms, for shorelegs and bracing under platforms, buildings and other structures. Second hand bridge ties are used for stock pen posts, wing fence posts, and right of way fence gate posts. Hardware recovered from old trestles, such as bolts, washers and spikes, is all used again in the reconstruction of the trestle as far as usable. Guard rail bolts that cannot be re-used as such are used in place of boat spikes or line spikes. Old chord bolts or sway brace bolts similarly damaged are used for drift bolts. By this plan it is found necessary to purchase very few drift bolts or boat spikes. The same rule is applied to water service material. When renewing wooden tubs, water tanks, etc., all usable material such as supports, staves and hoops is salvaged and used for replacing decayed staves or weak hoops and supports on other old tanks of similar construction. All second hand pipe is recovered and when necessary the ends are cut off and re-threaded. Globe valve seats are re-ground and the serviceable parts of old valves are used in making repairs. The same plan is followed with pumps. Only such parts are scrapped as cannot be used for repair work.

On the **New York, New Haven and Hartford** old bridge stringers are sometimes used to replace shorter ones, putting in an extra one where necessary to bring the structure up to the required strength; the poorer ones are used for curbings at outlying stations and are filled in with cinders and crushed stone and are also used for cribbing around back of freight stations, bank walls, etc. Old bridge ties are sorted over and the best are used to repair bridges where the majority of ties are still good for two or three years while others are used for caps and posts for freight platforms and underlays for station platforms. Recovered water pipe of 3-in. diam. or over, that is not good for high pressure, is used for drain pipe, and old leaky valves are sent to the storekeeper to be repaired.

The **Grand Trunk** reports that during the last few years a considerable number of light steel bridges have been taken out of service and that these are worked over and used in many ways, particularly for overhead highway bridges. A small shop has been instituted and is constantly engaged on this kind of work. Partly worn ties recovered from bridge decking are used again but without resawing. Worn out valves are repaired and put back into service. A special effort is also made to collect surplus and idle material and while this is not exactly reclamation it is a profitable thing to do.

Following is an outline of the practice on the **Lehigh Valley:** Lumber taken out of bridges and trestles is sorted, separating the partly good and the good material from that which is of no further use. It is

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old rail cover boxes and for grillage under bridges where they are raised to bring them up to the new ballast profile. All bridge ties removed are used in temporary work for supporting track where masonry changes are made. A great many old bridge ties are used for cribbing to hold a bank from sliding on the track. Scrap platforms are usually made from old bridge ties. A great many are sent to the mill and resawed into frog blocking, this one item alone saving many thousands of dollars yearly. The entire amount of frog blocking used on the system is made from old material and not a foot of new material is used. Oak pile butts are resawed into track shims. Old trestle timber is used over as far as possible. Timber that is fair is sent to the mill and resawed into plank and short ends are saved and used for blocking. As a rule that which cannot be employed to good advantage is used for fuel. Any material that can be used over or reclaimed to good advantage is so used. There are numerous ways of reclaiming materials from buildings, the best method depending largely on the condition of the structure to be demolished, and the care and maintenance it has received. Age should be considered. Old buildings have been demolished from which less than 10 per cent of the material can be used again. This is true of cheap buildings. Buildings of mill type or heavy construction will prove more profitable. Careful men only should be employed in demolishing structures, for a careless man will destroy more material than his wages would buy. The average saving in using reclaimed material from buildings is about 50 per cent. There is more to be saved or reclaimed in old brick buildings. Careful men will recover nearly all of the brick and at the present prices a great saving is made. Old brick are worth $10 per M., new brick $22, and for ordinary railroad structures the old are as good as the new. Doors and windows taken from old structures are usually of very little value, excepting for the glass. Railroad buildings generally get very hard treatment and doors are usually in bad condition. Plumbing, heating, leaders, gutters, etc., are only fit for scrap as a rule. Building codes in our cities will not permit the use of old plumbing or old wrought iron piping for steam heating or water. Such can only be used for temporary work and in most cases it would be better to use new piping and scrap the old. Electrical material can rarely be used again on account of the strict rules of the underwriters and is almost invariably scrapped. No certificate will be issued if any old material is used. Water supply material can be reclaimed in a great many cases. It is scarcely worth while to bother with digging up 3 in. and 4 in. pipe, but it will pay to take up 6 in. and 8 in. pipe at a cost of about 40 cts. per ft. Ten inch to 12 in. pipe can be dug up and reclaimed at a cost of about 75 cts. per ft. Considerable lead can be saved and at the present prices it will pay. Gate valves can be reclaimed very easily by using good judgment. All sizes of gate and globe valves can be worked over, new parts substituted where necessary, and a great saving made. Our men have instructions to keep this thought in mind and to re-use reclaimed material, especially for repair work. Pumps and boilers are usually sent to a shop for overhauling. Where a larger pump is desired, the old pump will be put in proper condition and used for emergency work. Boilers are treated in the same manner. When an old water column is taken out all parts that can be re-used are properly cared for and put in stock and re-used. Parts that are of no use are scrapped. Wooden water tanks are made to last as long as possible by reinforcing with extra hoops. If the posts and hoops are in good condition the tank proper will last for several years longer than one would naturally expect. When tanks are demolished the hoops that are sound are reclaimed; timbers may be used for temporary work and the staves for various work around buildings and on temporary construction. In all cases any and all material of any name or nature is re-used where it can be done advantageously and a saving made. Railroad men have gotten over the idea that all material used must be new. By not being able to get new material in many cases

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spikes, track material and miscellaneous materials are reclaimed and used in new and repair work at a very small percentage of the cost of new material.

It is not unlikely that the principle of reclamation may be overworked at times and that the cost of reclaiming old material may be as much as the cost of purchasing new, or that the recovered material may in the end prove of such inferior quality as not to pay for itself. This phase of the subject should be watched continually, and sufficient cost records kept to make sure that the work is economical and profitable. Good judgment should not be allowed to be set aside because of a wrong application of the principle. A case is cited in which a foreman made his carpenters pick up and straighten old shingle nails when station buildings were reshingled. New nails at that time cost 6 cents per pound and a man could straighten out about one pound of nails in two hours. The moral is obvious, although this is an extreme case. There are others that will take a little study and observation to decide but the point is that good judgment, common sense and close supervision will prevent any gross errors in this direction. Another instance in which reclamation did not pay is a case of brick recovered from an old engine house. A careful record was kept and it was found that by the time the brick had been cleaned and stored they cost $28 per thousand, not counting them of any value to start with. Adding to this the fact that the brick were of an old-fashioned type and much smaller than those in use now and could not be used with new brick, it is needless to say that this practice was soon discontinued. The above cases are cited by way of caution because it is not always easy to get at exact costs of work of this nature. Wherever possible costs should be kept because by so doing one's judgment will be improved and there is less need of experimenting.

Following is a case in which accurate records were kept. A 16 ft. by 24 ft. water tank complete with a 14 ft. husk frame, frost box and fixtures was taken out of service on the C. M. & St. P. after having been in use for many years, and was sent to the shops at Tomah, Wis., to be reclaimed or scrapped. By reworking and applying all of the usable material from the old tank and putting in new where necessary a tank was constructed and shipped out that was practically as good as new. The cost as compared with a new tank is shown in the following tabulation:

Prices used are those prevailing at the time the work was done.

	Allowance for old material used	New Material taken from stock	Labor	Total cost of reclaimed tank	Cost of a new tank
Tank tub,	$ 72.31	$75.27	$51.24	$198.82	$ 299.03
Hoops and lugs,	137.49		14.04	151.53	204.12
Roof,	41.28	62.51	12.57	116.36	122.98
Husk frame,	56.31	18.00	8.04	82.35	124.63
Frost box,	48.35	6.65	7.00	62.00	99.09
Fixtures,	68.12		16.88	85.00	108.00
I Beams,	144.21		11.79	156.00	172.72
Miscellaneous,		29.58		29.58	37.50
				$881.64	$1,168.07

It is suggested that in view of the prevailing high prices of material much saving can be made by carefully planning the use of both old and new material and thus avoid all possible waste. Special attention should also be given to second-hand material to see that it is taken care of promptly and properly.

The **Chicago & North Western** has three saw mills for working up old second-hand bridge timbers, located at Boone, Ia., Winona, Minn.,

and Norfolk, Neb. The two former are electrically equipped while the latter is operated by a gasoline engine of 30 h. p. Bridge timbers are sawed into all sizes of smaller standard material and the lumber used for small buildings of every description. The lumber which is too poor for any other service is used for firing up locomotives. Cedar pile heads are sawed into shingles. Other pile heads are used for jack handles, car stakes, etc. With careful supervision no lumber is wasted that is fit for service although this seldom was the case before the saw mills were installed. These mills have movable carriages operated by levers. The saws are 44 in. in diameter with inserted teeth which are replaced readily when damaged by bolts, spikes, etc.

Not only is the mill a necessity for sawing up second-hand material but it serves an excellent purpose for resawing odd sizes left over from the construction of engine houses, water tanks and such material as would otherwise have to be held on hand for years unless it was used to disadvantage without being sawed. The mill is also of particular advantage for sawing bevel ties, two such ties often being cut from a single length of good quality second-hand bridge stringers. The car department always has a lot of odd-sized hardwood timber on hand which may be sawed readily into special sizes for other purposes. Scrap and short pieces can be sawed into blocking for paving material, baggage room, shop floors, etc. Engineers' stakes, both hardwood and softwood, can be cut from scraps of material too small for other purposes. The same is true of running board saddles for freight cars, and many other items too numerous to mention.

The saw mill gang may be the same that handles material in a store yard or bridge material yard, reclamation yard, etc. The saw mill certainly pays if properly conducted.

G. T. Richards, C. M. & St. P., Chairman,
P. Aagaard, Ill. Cent.,
F. E. Schall, Lehigh Valley,
J. J. Murphy, Sou. Pacific,
W. A. Pettis, New York Central,
G. W. Andrews, Balt. & Ohio,
J. J. Wishart, N. Y. N. H. & H.,
W. J. Jackson, C. & N. W.,
Committee.

RECENT DEVELOPMENTS IN CONCRETE

By Lt. Col. H. C. Boyden
Portland Cement Association, 111 West Washington Street, Chicago

It is possible that some of the points to be brought out in this paper are more or less familiar to some of those present, through the reading of publications on the subject and the discussion of them in the technical press. There are many, however, to whom the facts will be new and of interest and the others may have questions they would like to have answered. If these questions are not answered in this paper, the Portland Cement Association will be glad to send further information.

The art of making concrete is an old one, but it is only in recent years that serious large scale investigations of its structure and the real effect of various combinations of the ingredients, have been undertaken.

In 1914 the Structural Materials Research Laboratory was established at Lewis Institute, Chicago, with Professor Duff A. Abrams at its head. The establishment of this laboratory was made possible through the coöperation of the Portland Cement Association and the Lewis Institute. This laboratory is a striking example of coöperation between an engineering college and a manufacturing industry of international scope.

There are only two ideas governing the policy of this laboratory: the first is, that the real facts regarding concrete and its ingredients shall be found out, with a liberal policy regarding the time required and the expense involved; the second is, that whatever the conclusions may be, they shall be given the engineering profession for the improvement of the art of making concrete.

These investigations are still being carried on, but many points of vital importance have already been established. As an example, the established data warrant the use of considerably higher unit stresses than those in common use today, with a consequent reduction in section. Conclusions have also been reached that will enable us to obtain excellent results with aggregates heretofore condemned and to increase greatly the ability of concrete to resist wear.

These conclusions and many others, are all based on tests running into the thousands and covering long periods of time. Incidentally, the laboratory is equipped for and is making close to 50,000 tests a year, so that there is no lack of facilities for carrying out investigations in the most thorough manner.

General

The study of concrete may be conveniently divided into three phases:

1. The study of the characteristics of the ingredients.
2. The study of the effect of making various combinations of these ingredients.
3. The study of the effect of the various manipulations of the ingredients in making and curing the concrete.

This paper will touch on only those investigations that have brought out essential changes in our previous ideas of the subject or have confirmed those ideas beyond a doubt.

It has been the custom to speak of concrete as having three ingredients, cement, fine aggregate and coarse aggregate. The laboratory studies have shown the desirability of classifying the ingredients as

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especially dark brown, reject the sand or wash it thoroughly before using.

The second fact is that with one exception fine sand behaves exactly the same as coarse sand. In order to produce a plastic workable mixture with fine sand it is necessary to use more water than with a coarse sand. It is the excess of water that reduces the strength of the concrete. In other words if concrete could be mixed with the same quantity of water regardless of the grading of the sand, and a plastic mix obtained in both cases, the same strength would be secured in the concrete.

Coarse Aggregate

When studying the characteristics of coarse aggregate one conclusion has been brought out very sharply; namely, that the hardness of the aggregate is a secondary consideration, as compared with other factors, in developing high crushing strength in concrete, and of less importance than ordinarily supposed in developing wearing qualities. This was very clearly shown in comparative tests made of burnt shale for use in building concrete ships. Samples made with this aggregate compared very favorably with those made with a much harder aggregate. A stone must be very friable indeed if it is not strong enough, when properly combined in concrete, to more than maintain the load likely to be carried by the concrete.

The reason for the high compressive results secured where a light, soft aggregate is used, is because the water content is reduced, owing to the porosity of the aggregate, and is not due to a higher compressive strength in the aggregate. Again the water content is the governing factor.

For road surfaces, however, another quality is needed in concrete, namely, wearing or abrasive quality, and to obtain this the stone must not be too soft. It is not advisable to use a stone with a French coefficient of less than 7, although pavements have given excellent results made with stone having a coefficient as low as 6.

It is not intended in calling attention to the above results to advise throwing down the bars and allowing the use of any and all stones, irrespective of their hardness or wearing qualities. It is desired, however, to show that many of the safeguards that have been put into specifications in past years are not safeguards at all, and that the effect of following them mav be entirely lost through neglect to observe other factors of more vital importance. It is also advisable to use the best materials obtainable, but there have been many cases, where the local and easily obtainable material has been rejected, when it could have been used with excellent results, by following proper principles in proportioning and protecting the concrete.

Oftentimes better results would have been obtained than resulted from the use of imported materials and then neglecting the really important factors in making good concrete.

Water

The remaining ingredient of concrete, water, is in reality, of equal importance with the cement in obtaining good concrete, and yet it is often the most carelessly used and most loosely specified of all the ingredients, generally not being mentioned in specifications and frequently not even reported in test data.

The laboratory is now conducting tests of waters sent in from all parts of the country, but definite conclusions have not as yet been developed. It is safe to say, however, that waters which are strongly alkaline should not be used, and, owing to the possibility that marsh waters may contain sufficient humus matter to affect seriously the strength of concrete, they should be looked upon with suspicion until tested in concrete and found satisfactory.

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the country Prof. Abrams has worked out a table containing 135 proportions with different combinations of aggregates, which if used with materials acceptable as to quality, will give a concrete with a compressive strength at 28 days of approximately 3,000 lb. per sq. in. All the tests for the determination of the factors in this table were made of a concrete of a workable plasticity, formed into cylinders 6"x12" in size and tested at the end of 28 days.

In conformity with present practice the aggregate is divided in the table into fine and coarse, and covers combinations of five classes of fine aggregates with twenty-seven classes of coarse aggregates.

In order to determine in what class a known aggregate shall be placed, the following rules should be followed: If it is a fine aggregate at least 15 per cent of the total shall be retained on the next smaller sized sieve; if it is a coarse aggregate at least 10 per cent shall be retained in the same manner.

This table shows a considerable reduction in the amount of cement required as compared with previously published tables, especially when combined with the larger sizes of aggregates. As an illustration, the quantities used today for a 1:2:3 mix, with sand up to No. 4 and stone from No. 4 to 1½" are 1.74 bbls. cement; 0.52 cu. yds. sand and 0.77 cu. yd. of stone, per cu. yd. of concrete. Concrete designed according to Prof. Abrams' table requires 1.61 bbls. cement, 0.47 cu. yd. sand and 0.72 cu. yd. stone per cu. yd. of concrete.

These figures are the exact quantities required for the making of one cubic yard of concrete, having a strength of 3,000 pounds, and if used will effect a very material saving in the cost of concrete roads and pavements, and other concrete structures to be built in the years to come.

An allowance for waste, varying for each ingredient and also according to the particular method employed in handling the work, should be added to the quantities given in the table. Professor Abrams is now preparing tables similar to the one already published, for concrete with compressive strengths of 2,000 and 2,500 lbs. per square inch. As soon as these tables are completed they will be published in the technical press.

Water Content

It is upon studying the water content that the most radical change from previous ideas on the design of concrete mixtures is found.

Based upon thousands of tests it has been established that there is a direct connection between the amount of mixing water used and the strength of the concrete and there is probably no other one factor which has so great an effect upon the strength as the water content.

It has been found that the less water used down to a certain point, the stronger will be the concrete, but this does not mean that the amount of water can be reduced too far, nor that in actual construction it can be reduced to a point that would give the maximum strength shown in laboratory tests. There is another factor that must be taken into account in construction and that is the workability of the mix. In general terms it can be stated that the lowest amount of water should be used that will give a workable mix.

The strength falls off very quickly with the addition of a small amount of water; so much so that in a one bag batch the addition of one pint of water more than is necessary to give a workable mix produces the same loss in strength as if two or three pounds of cement had been left out. Do not think from this that a very lean mix with a small quantity of water will give as strong a concrete as a rich mix with the same quantity of water. This is not true, because it will require a higher water-ratio to produce a workable mix with the lean mixture, thereby causing a loss in strength.

The proper consistency for concrete will vary according to the use to be made of it. If the concrete is to be used for roads a dryer con-

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troversy over the time of mixing and to insure a full minute mix. When a mixer is manufactured that will not permit discharge until a certain number of revolutions have been made at a certain speed this problem will have been solved.

The revolutions per minute of the mixer within the limits of 12 to 25 R. P. M. have but very little effect on the strength of the concrete, so that a sufficiently wide variation for different machines is permitted. In making tests of the effect of R. P. M. on concrete the total time was one minute in all cases, and all materials, including water, were placed in the drum before the time interval was counted.

The effect of pressure on concrete immediately after moulding is found to be due to the amount of water squeezed out, making a consequent reduction of the water-ratio. Tests were made on concrete of the same proportions, by applying pressure from zero to 500 lb. per sq. in. The water expelled was carefully collected and measured. It was found the strength increased quite materially with the higher pressures and this increased strength was almost directly proportional to the amount of water squeezed out. It is not surprising to find, then, that the duration of the pressure had no effect whatever on the strength of the concrete. Whether pressure was applied for a few minutes or for several hours the effect produced was exactly the same. It is undoubtedly the squeezing out of the water and consequent reduction of water-ratio that produces the excellent results when the roller method of finishing concrete roads is used.

The time that can be allowed between the time of mixing and the time of placing has not as yet been made the subject of extensive tests at the laboratory. This knowledge is of value when considered in conjunction with central mixing plants, which are used with success in many places. The lapsed time is undoubtedly governed to a certain extent by the kind of cement used, by the temperature of the ingredients and by the temperature of the mixed concrete. In Illinois a limit of 40 minutes lapsed time is allowed, but it is generally believed that the economical haul for the job will be the governing factor rather than the fixing of a time limit.

It is possible that some of the present ideas regarding this factor may be changed by the results of such a series of tests, but until such a time it would not be advisable to allow re-tempering of concrete that has been too long in transit, as the addition of water will no doubt result in a reduction in strength.

Protection

The proper protection of concrete during the early hardening period is a detail of construction that is only too often overlooked and many times only indifferently carried out. The effect of proper curing conditions upon the ability of the concrete to withstand abrasion has been very strongly brought out by numerous tests in the laboratory. There is probably no factor in the handling of concrete that so affects its wearing ability, as that of providing proper protection while curing or hardening.

It is true that any and all of the factors that tend to produce strength in concrete also tend to increase its wearing qualities; nevertheless all of our tests show that other factors being the same, the concrete which is properly protected will show much less wear than that which has been allowed to dry out too quickly. As an illustration of this, the strength of a concrete of 1.25 consistency was about 1,700 lb. per sq. in. when it was allowed to dry out in the air unprotected, while exactly the same concrete stored in damp sand for 21 days gave a strength of about 4,000 lb. per sq. in., and a correspondingly less wear under the rattler test.

One of the principal causes of the poor wearing resistance that is sometimes found in concrete floors is due to the practice of allowing

them to dry out without proper protection during the hardening period. Concrete floors under roof should be covered and kept moist just as outside roads and pavements are protected. Why throw away one-half of the life of a concrete floor by failing to observe this rule and holding back from using them for so short a period?

The essential requirements for proper hardening are warmth and the presence of moisture, especially the latter. The tests show a less increase in wearing resistance and strength after 21 days have elapsed and a constant rate of increase during this period. In deciding on the length of time that a pavement, or other structure, shall be kept covered and moist, it is simply a matter of deciding how much of the potential strength and wear resisting qualities it is desirable to throw away, and reducing the 21-day period by that amount.

There are several methods of protecting concrete pavements during this period, the most effective of which is the ponding method, and where the grades and other conditions will permit this method to be used, it will give the most lasting results. The protection of concrete structures other than pavements is very often either neglected altogether or at best only half carried out. Many times the leaving on of the forms is considered to be sufficient protection in itself, but this is not so.

The forms and all exposed surfaces should be kept thoroughly wet or, at least very moist continuously for not less than 14 days and whenever possible for 21 days or more.

Conclusion

This paper outlines to you some of the more important developments resulting from the studies at the laboratory. It has a double object: First, to impress upon you the advisability of designing each concrete mixture to produce a concrete of a certain desired strength, with the particular ingredients available. Second, to show you how the desired results could be obtained.

In reviewing the methods to be employed in obtaining good concrete there are two points which stand out above all others, and if these are followed more good will have been done than by following all other refinements put together. The first of these is: that the least amount of mixing water shall be used that will give a workable mix, and not one drop more. The second is: that no matter with what care the ingredients are chosen, proportioned, mixed and placed, a considerable portion of the beneficial results of this care will be nullified unless the concrete is kept moist during the early hardening period.

A CENTRALIZED ORGANIZATION FOR FEEDING MEN

By Hunter McDonald
Chief Engineer, Nashville, Chattanooga & St. Louis Ry.

When I began work for the Nashville, Chattanooga & St. Louis in 1879, all the men in extra gangs, called then floating gangs, and still called so by the men themselves, were paid 60 cents per day, quartered in boarding cars called cabooses, and fed at the company's expense. Section men were paid 75 cents per day, and given their house rent and old ties for fuel when living in company houses. Early in the '80s these rates were advanced to 70 and 90 cents, respectively. From 70 cents the rate gradually advanced to $1 in 1916. At this time extra gang labor became unusually scarce, and consequently very inferior in quality. In order to recruit and improve the forces, their rate of pay was advanced from $1 to $1.40. No deduction has ever been made for board, it being a part of the compensation. No deduction is made for board on rainy days when the men do not work. They have always been permitted to make week-end trips to their homes, which are usually as far away from their work as the foreman will stand for. All extra gang laborers are negroes, although we have had such gangs composed of native whites when negroes could not be obtained. The class of negroes secured on these gangs has generally been inferior to that on the section gangs.

Section gangs in mountain regions are either all native white or mixed white and negro. In strictly agricultural regions they are, with few exceptions, negroes. The forces usually fall off when planting season arrives and increase when crops are laid by. Many of the negroes on extra gangs are unmarried, many are ostensibly polygamists, visiting different homes at different week-ends, many are gamblers, and most of them were drinkers before prohibition made it impossible for them to get whisky. Some of them are preachers and all are gregarious. They like "floating," as they call it, because the food is better and more plentiful than they get elsewhere, because of their love of the "gang" and the enjoyment of the week-end trip on the train, with a check in the hat band which is exhibited at every station while the wearer is awake by sticking his head out of the window. In one or more of their sleeping cars there is usually a preacher and a banjoist, and all of them sing both in camp and at work. Most of their work is done to musical calling or timing by their squad leader.

In 1907 the system of feeding the men was extended to bridge and building gangs, composed altogether of native white men. Prior to that time these men were either boarded by the foreman or they "messed," buying their food, employing the cook and dividing the expenses at the end of the month. The foreman generally received his board free as compensation for looking after the mess. The company furnished the cook stove, utensils and fuel and dining room equipment.

At the time of instituting the system of feeding all the men living in outfit cars, the board, including the cook's pay, was estimated to cost 30 cents per day for extra gangs and 35 cents for bridge and building gangs. Later, as the price of food and wages of cooks advanced, the charges were increased to 50 cents for extra gangs and 60 cents for bridge and building gangs. Stoppages for board at 60 cents per day are made on pay rolls for men on bridge and building gangs. The foreman is boarded free in consideration of his superintending the boarding.

The system of purchasing supplies up to this time was for each division engineer to take bids monthly for the requirements of his division and award the contract for the supplies to the lowest bidder.

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The commissary agent checks all requisitions carefully and sees that they are properly balanced as to food values and in accordance with the ration allowance for the estimated number of men to be worked for the succeeding month. After the quantities to be purchased are determined, bids are solicited from reliable firms for such as are not already in stock. Complete specifications accompany all solicitations for bids. Orders are awarded to the lowest bidder on any article, regardless of whether or not his bid is the lowest on all the articles.

The goods for shipment to the men are packed at the commissary in Nashville in substantial cases and coverings, which are returned promptly and used as long as they are serviceable. Invoices are sent by train mail and also packed with the goods. These are checked by the foreman and returned to the division engineer, who O. K.'s and forwards them to the commissary agent.

Perishable goods are forwarded by baggage, others by local freight. The company's telephone is used freely to keep in touch with gangs which are moved unexpectedly. Comparative statements of costs for each gang are made up in the chief engineer's office and blueprint copies sent to all division engineers. It is the duty of the division engineers to note all cases of apparent extravagance or dishonesty of cooks, and the commissary agent also calls attention to irregularities.

A lunch club is operated in the purchasing department and the food for it is furnished at cost by the commissary agent. He thus makes a practical test of the quality of all foodstuffs purchased and none are sent out that are not known to be of quality specified and in good condition.

Three months after the inauguration of the plan the balance was on the company's side of the ledger. Advances in foodstuffs and cooks' wages have again run the cost above the price charged. By the experience already gained and training of cooks and foremen, the loss has not yet reached a point where a raise in the board is considered imperative. It is hoped that with the advent of lower food costs, notwithstanding recent very heavy advances in cooks' wages, the balance will again fall below the price charged. It is our purpose to feed the men at cost, and when our recent losses are made good and conditions justify, it is expected that the boarding charge will be reduced.

Statement of Boarding Cost

Bridge Gangs

	1918	1919
Average cost, with cook, per man, per day	$ 0.621	$ .618
Average food cost	.452	.407
Man days worked	104,544	84,120

Track Gangs

	1918	1919
Average cost, with cook, per man, per day	$ .536	$ .460
Average food cost	.406	.322
Man days worked	109,159	91,948

Bridge gang, 1918, worked 104,544 man days, loss $0.02 over $.60 per day	$ 2,090.88
Track gang, 1918, worked 109,159 man days, loss $0.036 over $.50 per day	3,929.72
Total loss	$ 6,020.60
Bridge gang, 1919, worked 84,120 man days, loss $0.018 over $.60 per day	$ 1,514.16
Track gang, 1919, worked 91,948 man days, gain $0.04 under $.50 per day	3,677.92
Net gain	$ 2,163.76

So far as I know, the plan above outlined of feeding maintenance of way employees is unique. It has many advantages. The men are contented and the gangs are generally full. With present good wages, the quality of the labor will improve greatly. In case of wrecks or washouts, complete outfits are at hand to feed section men and other additional forces who have to be assembled quickly. The meals are furnished promptly, well cooked and served, which is not always the case where the messing system is adopted. The cost is much less to the men than they could obtain by any other method. There is no profiteering on the men, such as may often be the case where they are boarded by contractors or by the foremen. The computed cost for board includes the cook's wages. In many cases on other railroads the cook is furnished at the expense of the railroad where a gang consists of six or more men. Men who are entitled to have their expenses paid while traveling are often fed at the boarding cars at a substantial saving.

[Copies of the blank forms mentioned in this article may be had by addressing the chief engineer of the N. C. & St. L. Ry.]

MAINTENANCE OF WAY COMMISSARY SERVICE

By M. C. Threlkeld, San Francisco, Calif.
(Proceedings Pacific Railway Club)

The question of feeding maintenance of way employees is rather a difficult game requiring considerable organization and preparation.

In the first place, to serve a large number of widely scattered boarding camps is no small task. I think at present I have about 200, running from El Paso, Texas, to Portland, Oregon, and to Ogden on the Southern Pacific, to Salt Lake City on the Western Pacific, and Trinidad on the Northwestern Pacific, also a number of oil company camps. The business started from one outfit, which I, as Southern Pacific Company foreman, was running, and which seemed to be run satisfactorily enough, so that I was asked to take another and another, until I think I had five. When I had to take another, I left one job to take the other.

To begin with, of course, it was not very difficult to obtain supplies, and up to the time of the fire, I was fairly successful in getting various brands of food, furnishing and serving those brands in various localities, but during and after the fire, I was in such desperate straits that I thought I would at that time start my own base of supplies, or my own wholesale grocery house, which I did, and I find that that is, perhaps, the lead or first base from which to render an efficient service on a large territory. A central depot, properly selected for efficient, quick delivery, and a thoroughly practical class of food, greatly assists in rendering good universal service all over the system; for instance, in flour, I am using Sherry's "Drifted Snow." If a cook goes to one outfit and uses one brand of flour, and I send him to another outfit and furnish another brand of flour, and perhaps another brand of baking powder (this is merely by way of illustration), confusion results. In the meantime he has wasted several batches of bread. That applies to various brands of canned goods and the various other classes of foods, which should be prepared without failures, because the class of men fed can not afford more than the least possible price that can be paid for their sustenance in the various boarding camps away from home. Hence, I endeavor to collect in the season, the season's goods, so that the lowest price may be obtained to tide over the period when prices are high. Thus, employees get the benefit of that selection and the brands of food are the same all over the system. A cook coming in from our outfit in Arizona and sent to Oregon finds the same brands of food there, also the same range, utensils, etc., and this is necessary in that class of work. Now these goods collected in a store must then have systematic, careful and quick shipping, if company employees are properly fed. Very often they want an outfit started out in an hour, or two. A well used truck will almost get out and get the stuff itself and place it for shipment, and the outfits will, if they are being started new, be complete. The store has a list of everything that is necessary, from a steel range to a teaspoon, from a sack of potatoes to canned goods, so that all that is necessary is to say to the store, "Send an outfit to such and such a place for 5, 10, 15 or 1,500 men." And when shipment is made, or in fact, before, a cook must be found and started for the same place; and getting proper cooks is a very difficult task at the present time. I think the best cooks that I have at present are cooks whom we have trained ourselves, training them from waiters, and we have all classes. The class which gives the best service is the Chinese. They are very intelligent, very loyal, very cleanly. Sometimes they are a little prone

to sameness in the camp cooking, but they are always on hand, and the meals are clean and served and prepared in a wholesome manner.

When the food gets to the outfit, which possibly comes from another point, the outfit should be properly screened so as to keep out flies.

The camp should be made as sanitary as possible, and the men should be given wholesome food served on time, and their sleeping quarters should be clean and comfortable.

When the outfit is started, it needs a very tactful man as a traveling steward, where there are foremen, road masters, supervisors of telegraph, and division foremen to keep satisfied. It is a very difficult matter to have them all satisfied and pleased with the board. While we are all subject to mistakes, when we are doing the best we can, it is but natural we will find some who will complain of the food, and the best that you can do is sometimes very far amiss with some people, although possibly very satisfactory to others. The great majority of men, however, when you place the matter in the right light before them, are reasonable, and I will say that the class of foremen in the B. and B. Department of the Maintenance of Way, I consider a class of the finest, most honorable men, or as much so, at least, as any other class of railroad men in existence. Starting my own camp in '95, I have been meeting these men continually since, and almost every time they will meet you half way, when they realize you are trying to do what is right, and it is very easy to do business with that class of men when the men are properly housed and served with the proper food. I am not able to give you the exact figures, but I send out about 300 sacks of sugar per month, 600 sacks of potatoes, about 1,200 quarters of flour, etc., in round numbers between thirty and fifty thousand dollars' worth of supplies from my own store during the month, and it is a difficult job at best, requiring efficiency and organization. I have prepared, loaded and shipped a 400-man outfit complete with all food necessary except fresh meat, all utensils, eight or ten ranges, etc., transported same 500 miles, and served one meal at the end of twenty-six hours, and that requires quick, efficient work.

Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Colo.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428
21	St. Louis, Mo.,	Oct. 17-19, 1911	499
22	Baltimore, Md.,	Oct. 15-17, 1912	524
23	Montreal, Que.,	Oct. 21-23, 1913	570
24	Los Angeles, Cal.,	Oct. 20-22, 1914	586
25	Detroit, Mich.,	Oct. 19-21, 1915	665
26	New Orleans, La.,	Oct. 17-19, 1916	710
27	Chicago, Ill.,	Oct. 16-18, 1917	704
28	Chicago, Ill.,	Oct. 15-17, 1918	716
29	Cleveland, O.,	Oct. 21-23, 1919	776
30	Atlanta, Ga.,	Oct. 26-28, 1920	840

	1907-1908.	1908-1909.	1909-1910.	1910-1911.
President ...	R. H. Reid......	J Canty	J. S. Lemond...	H. Rettinghouse
1st. V.-Pres.	J. P. Canty.....	H .ettinghouse..	H. Rettinghouse.	F. E. Schall
2nd. V.-Pres.	H. Rettinghouse..	F . Schall.....	F. E. Schall....	A. E. Killam
3rd. V.-Pres.	F. E. Schall	J Lemond....	A. E. Killam...	J. N. Penwell
4th. V.-Pres.	W. O. Eggleston.	A . Killam....	J. N. Penwell..	L. D. Hadwen .
Secretary	S. F. Patterson..	S . Patterson..	C. A. Lichty....	C. A. Lichty
Treasurer ...	C. P. Austin ...	C . Austin...	J. P. Canty....	J. P. Canty
Executive Members	A. E. Killam....	J. Penwell....	W. Beahan	T. J. Fullem
	J. S Lemond.....	W rd Beahan ..	F. B. Scheetz .	G. Aldrich
	C. W. Richey....	F B. Scheetz...	L. D. Hadwen .	P. Swenson
	T. S. Leake......	V H. Finley...	T. J. Fullem....	G. W. Rear
	W. H. Finley....	L . Hadwen ..	G. Aldrich......	W. O. Eggleston
	J. N. Penwell....	T . Fullem....	P. Swenson....	W. F. Steffens

	1911-1912.	1912-1913.	1913-1914.	1914-1915.
President	F. E. Schall	A. E. Killam....	J. ell ..	L. D ..
1st. V.-Pres. .	A. E. Killam ...	J. N. Penwell...	L en ..	G. A ...
2nd. V.-Pres.	J. N. Penwell ...	L. D. Hadwen...	G	G. V ...
3rd. V.-Pres.	L. D. Hadwen ..	T. J. Fullem....	G	C. E ...
4th. V.-Pres. .	T. J. Fullem ...	G. Aldrich	C	E. B ...
Secretary	C. A. Lichty	C. A. Lichty.....	C	C. A ...
Treasurer	J. P. Canty	J. P. Canty....	J.	F. E ...
Executive Members	G. Aldrich	G. W. Rear....	V ens ..	W. I ..
	P. Swenson	W. F. Steffens...	E	S. C ...
	G. W. Rear ...	E. B. Ashby....	S r ...	Lee ...
	W. F. Steffens ..	C. E. Smith....	L	W. I ..
	E. B. Ashby ...	S. C. Tanner....	W use ..	C. R ..
	W. O. Eggleston	Lee Jutton	C ce ..	A. Ridgway .....

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear.....	C. E. Smith	S. C. Tanner.....	Lee Jutton
1st. V.-Pres.	C. E. Smith ...	E. B. Ashby	Lee Jutton......	F. E. Weise
2nd V.-Pres.	E. B. Ashby ...	S. C. Tanner	F. E. Weise.....	W. F. Strouse
3rd V.-Pres.	S. C. Tanner ..	Lee Jutton	W. F. Strouse...	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles..	A Ridgway
Sec.-Treas. ..	C. A. Lichty ..	C. A. Lichty	C. A. Lichty.....	C. A. Lichty
Executive Members	F. E. Weise ...	W F. Strouse ...	A. Ridgway.....	J. S. Robinson
	W. F. Strouse ..	C. R. Knowles ..	J. S. Robinson...	J. P. Wood
	C. R. Knowles .	A. Ridgway	J. P. Wood.....	A. B. McVay
	A. Ridgway	J. S. Robinson ..	D. C. Zook.......	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay.....	E. T. Howson
	J. P. Wood ...	D. C. Zook	J. H. Johnston..	C. W. Wright

	1919-1920		1920-1921
President ...	F. E. Weise	President	W. F Strouse ..
1st. V.-Pres.	W. F Strouse ..	1st V.-Pres.	C. R. Knowles .
2nd V.-Pres.	C. R. Knowles .	2nd V.-Pres.	A. Ridgway ..
3rd V.-Pres.	A. Ridgway ...	3rd V Pres.	J. S. Robinson..
4th V.-Pres.	J. S. Robinson ..	4th V.-Pres.	J P Wood ...
Sec.-Treas. .	C. A. Lichty ...	Sec.-Treas. ...	C A Lichty .
Executive Members	J. P Wood	Directors	C. W. Wright ..
	A. B. McVay ...		A. B McVay
	J. H. Johnston ..		G A Manthey
	E. T. Howson ...		E. T Howson ..
	C. W. Wright ..		J H Johnston
	G. A. Manthey ..		E. K. Barrett

CONSTITUTION*

ARTICLE I.

NAME

Section 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT

Section 1. The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussions.

Section 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP

Section 1. The membership of this association shall consist of two classes—active and life members.

Section 2. To be eligible for active membership, a person must be in responsible charge of the design, construction or maintenance of railway bridges, buildings or other structures directly, in a consulting capacity, or in the employ of a public regulatory body; a professor of engineering in a college or university of recognized standing; an engineering editor or a government or private timber expert. All applications for membership shall be referred to the membership committee, consisting of three members of the executive committee, one of whom shall be a past president, and these applications shall be approved by this committee before submission to the association for election.

Section 3. To be eligible for life membership, a member must have been a member of the association for at least five years and in general must have retired from active railway service, although the association may waive the latter condition by a majority vote of the members at a regular session for good and sufficient reasons. Life members shall be elected on the recommendation of the executive committee, which committee shall report its recommendations to the association annually. A life member shall have all the privileges of active membership and shall not be required to pay annual dues.

*Revised 1920.

Section 4. Any member guilty of conduct unbecoming a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, may forfeit his membership on a two-thirds vote of the executive committee.

Section 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

ARTICLE IV.

OFFICERS

Section 1. The officers of this association shall be a president, four vice-presidents, a secretary-treasurer and six directors who with the most recent past president shall constitute the executive committee.

Section 2. The past presidents of this association, other than the most recent past president, who continue to be members, shall be privileged to attend all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE

Section 1. The executive committee shall manage the affairs of the association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the association, and make all necessary purchases and contracts required to conduct the general business of the association but shall not have the power to render the association liable for any debt beyond the amount then in the treasury and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

Section 2. Meetings of the executive committee may be called by a majority of the members of the committee, providing 10 days' notice is given members by mail.

Section 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE

Section 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reelection.

Section 2. The president, four vice-presidents and secretary-treasurer shall hold office for one year and the directors for two years, three being elected each year. All officers retain their offices until their successors are elected and installed.

Section 3. The term of office of the secretary-treasurer may be terminated at any time by a two-thirds vote of the executive committee. His compensation shall be fixed by a majority vote of the executive committee. The secretary-treasurer shall also serve as secretary of the executive committee.

Section 4. The secretary-treasurer shall be required to give bond in an amount to be fixed by the executive committee.

ARTICLE VII.

MEMBERSHIP FEE AND DUES

Section 1. Every member upon joining this association shall pay to the secretary-treasurer an entrance fee of $3 and annual dues for one year. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears may be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

BY-LAWS*

TIME OF MEETING

1. The regular meeting of this association shall convene annually on the third Tuesday in October at 10 a. m.

PLACE OF MEETING

2. The place of holding the next annual convention shall be selected by ballot at the annual meeting of the association. All the places proposed shall be submitted to a ballot vote of the members present at the annual business session and the place receiving a majority of all votes cast shall be declared the location of the next annual meeting. If no place receives a majority of the votes cast, the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

3. It shall lie within the power of the executive committee to change the location or time of the meeting if it becomes apparent that it is for the best interests of the association.

QUORUM

4. At the regular meeting of the association, 15 or more members shall constitute a quorum.

*Revised 1920.

DUES

5. The annual dues are $4 per year, payable in advance.

DUTIES OF OFFICERS

6. The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall, with the secretary-treasurer, sign all contracts or other written obligations of the association which have been approved by the executive committee. At the annual meeting the president shall present a report containing a statement of the general condition of the association.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

8. It shall be the duty of the secretary-treasurer to keep a correct record of the proceedings of all meetings of this association, and of all accounts between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

NOMINATING COMMITTEE

9. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, which shall prepare a list of names of nominees for officers to be voted on at the next annual convention, in accordance with Article VI of the constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE

10. Prior to each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary-treasurer and certify as to the correctness of his accounts.

COMMITTEE ON SUBJECTS FOR DISCUSSION

11. After each annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEE ON INVESTIGATION

12. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE

13. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS

14. Call to order by president.
Opening prayer or invocation.
President's address.
Reading minutes of last meeting.
Report of secretary-treasurer.
Report of membership committee.
Admission of new members.
Recess to permit registration of members and payment of annual dues.
Appointment of special committees.
Reports of standing committees and presentation of papers.
Unfinished business.
New business.
Selection of place for next annual meeting.
Election of officers.
Installation of officers.

Adjournment.

DECISIONS

15. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the association, unless otherwise provided. Unless specifically provided herein otherwise all discussions shall be governed by Robert's rules of order.

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Alexander, S. Y., G. F. B. & B., St. L. B. & M. Ry., Kingsville, Tex.
Alexander, L. B., Asst. Br., Engr., M. C., Detroit, Mich.
Allard, E. E., For. B. & B., Mo. Pac. Ry., St. Louis.
Althof, L. W., Asst. Engr., U. P. R. R., Omaha, Neb.
Anderson, August, Gen'l For. B. & B., L. S. & I. Ry., Marquette, Mich.
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Andrews, G. W., Asst., M. of W. Dept., B. & O. R. R., Baltimore, Md.
Andrews, T. O., L. E. & W. R. R., Tipton, Ind.
Archbold, H. L., Asst. Engr., Sou. Pac. Co., Portland, Ore.
Arey, R. J., 541 So. Cummings St., Los Angeles, Calif.
Ashby, E. B., Consulting Engr., L. V. R. R., New York City.
Ashley, J. L., Asst. For. B. & B., M. P. R. R., McGehee, Ark.
Ashmore, A. B., Supv. B. & B., M. L. & T. Co., Lafayette, La.
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Auge, E. J., Chief Carp., C. M. & St. P. Ry., Austin, Minn.
Azer, Wm. J., Supv. B. & B., C. & N. W. Ry., Chicago.

Bach, C. F., Supv. B. & B., C. & N. W. Ry., Belle Plaine, Iowa.
Bailey, F. W., Supt. M. of W., S. A. & A. P. Ry., Yoakum, Tex.
Bailey, S. D., 633 Hubbard Ave., Detroit, Mich.
Bainbridge, C. N., Engr., Design, C. M. & St. P. Ry., Chicago.
Ballard, C. F., Carp. For., S. A. L. Ry., Peachland, N. C.
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Barrett, J. E., Supt. of Track, B. & B., L. & H. R. Ry., Warwick, N. Y.
Barry, E. J.
Barton, M. M., 311 No. 34th St., Philadelphia, Pa.
Bates, Onward, Civil Engineer, McCormick Bldg., Chicago.
Batey, W. A., Supv. B. & B., U. P. R. R., Omaha, Neb.
Beard, A. H., 705 No. 11th St., Reading, Pa.
Beatty, L. D., Supv. B. & B., Sou. Ry., Princeton, Ind.
Bechtelheimer, A. E., Genl. Br. Insp., C. & N. W. Ry., Chicago.
Beck, L., Supt. B. & B., Virginian, Victoria, Va.
Beeler, C. L., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
Beeson, R. W., Mast. Carp., C. & S. Ry., Trinidad, Colo.
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Bennett, W. J., Asst., Engr., G. N., Seattle, Wash.
Benz, F. A., Div. Engr., B. R. & P. Ry., E. Salamanca, N. Y.
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Bigelow, F. M., Supv. B. & B., L. A. & S. L. R. R., Salt Lake City.
Bishop, McClellan, Sta. Mast., C. R. I. & P. Ry., El Reno, Okla.
Black, G. W., Supt. McGrath Sand Co., 1256 S. Oak St., Freeport, Ill.
Black, J. D., Supv. B. & B., P. M. R. R., Saginaw, Mich.
Blake, L. M., Supv. B. & B., B. & M. R. R., St. Johnsbury, Vt.
Blowers, S. H., For. Carp., B. & O. R. R., Columbus, O.

Bock, J. G., Gen. Br. Insp., C. St. P. M. & O. Ry., St. Paul, Minn.
Bohland, J. A., Br. Engr., G. N. Ry., St. Paul, Minn.
Bonner, J. K., Asst. Supv. B. & B., N. Y. C. R. R., Rochester, N. Y.
Bouton, W. S., Engr. of Brgs., B. & O. R. R., Baltimore, Md.
Bowers, Stanton, Bradford, O.
Bowers, S. C., Mast. Carp. of Brgs., P. C. C. & St. L. Ry., Steubenville, O.
Boyd, G. E., Div. Engr., D. L. & W. R. R., Buffalo, N. Y.
Boyer, Grant, Div. For. Bldgs., M. C. R. R., Detroit, Mich.
Bracken, T. F., Gen. For., B. & B., C. St. P. M. & O., Emerson, Neb.
Bradley, A. P., Roadmaster, Sou. Ry., Atlanta, Ga.
Bratten, T. W., Supv. B. & B., S. P. Co., Oakland Pier, Calif.
Brewer, W. A., Asst. Engr., C. & N. W. Ry., Chicago.
Bricker, H. R., 746 Reservoir St., Baltimore, Md.
Briggs, B. A., 1075 LaFayette St., Denver, Colo.
Brink, E. B., Supt. B. & B., L. E. & W., Tipton, Ind.
Brooks, G. E., Mast. Carp., C. R. I. & P. Ry., Rock Island, Ill.
Brooks, W. H., Supv. B. & B., C. of Ga. R. R., Columbus, Ga.
Brown, C. W., Sou. Pac. Co., Mina, Nevada.
Brown, E. H., Supv. B. & B., N. P. Ry., Minneapolis, Minn.
Brown, J. C., B. & B. Mast., D. & H. Co., Plattsburgh, N. Y.
Brown, Thos., Br. Insp., P. M. R. R., Saginaw, Mich.
Browne, J. B., Gen'l For. B. & B., K. C. C. & S. Ry., Clinton, Mo.
Browne, J. S., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
Bruce, R. J., Gen'l Bldg. Insp., Mo. Pac. Ry., St. Louis, Mo.
Bryson, H. L., Mast. Carp., S. A. L. R. R., Hamlet, N. C.
Buckley, J. E., Supv. B. & B., B. & M. R. R., Fitchburg, Mass.
Bulger, Hugh, For. B. & B., Sou. Pac. Co., Oakland Pier, Calif.
Buchholz, H. C., St. Maries, Idaho.
Bugg, C., Supv. W. S., G. T., London, Ont.
Burckhalter, F. L., Asst. Gen. Mgr., Sou. Pac. Co., San Francisco, Cal.
Burgess, W. H., Supv. B. & B., Sou. Pac. Co., Stockton, Calif.
Burke, Daniel, Supv. B. & B., Sou. Pac. Co., Tucson, Ariz.
Burnett, W. L., For. B. & B., Mo. Pac. R. R., Eudora, Ark.
Burns, Fred, G. F. Carp., C. N. O. & T. P., Somerset, Ky.
Burns, W. E., Ferry and High Sts., Salem, Ore.
Burpee, Moses, Chief Engr., B. & A. R. R., Houlton, Maine.
Burrell, F. L., Supv. B. & B., C. & N. W. Ry., Fremont, Neb.
Busier, T. W., Plumb. For., B. & A. R. R., Pittsfield, Mass.

Cable, C. C., 11 Franklin St., N. E., Washington, D. C.
Caldwell, C. H., For. B. & B., Sou. Pac. Co., E. Bakersfield. Calif.
Caldwell, J. M., Insp. B. & B., C. I. & L. Ry., Lafayette, Ind.
Caldwell, J. T., For. B. & B., Sou. Pac. Co., Bakersfield, Calif.
Camp, W. M., Editor, Railway Review, Chicago, Ill.
Candee, Eldridge E., Sup. B. & B., NY NH & H RR, New London, Conn.
Candee, Elliot E., Dist. Br. For., N. Y. N. H. & H. RR, Waterbury, Conn.
Canty, J. P., Div. Engr., B. & M. R. R., No. Adams, Mass.
Cardwell, W. M., Supv. B. & B., W. T. Co., Washington, D. C.
Carmichael, Wm., 2736 Walker Ave., Kansas City, Kans.
Carmody, M. M., Supv. B. & B., Sou., Big Stone Gap, Va.
Carpenter, J. T., 411 E. Broadway, Princeton, Ind.
Cary, E. L., Richmond, Mo.
Case, F. M., For. W. S., C. & N. W. Ry., Belle Plaine, Iowa.
Casey, W. W., For. B. & B., K. C. S. Ry., Texarkana, Tex.
Casserly, N. J., Br. Insp., Sou. Pac. Co., San Francisco, Cal.
Catchot, A. J., Supv. B. & B., L. & N. R. R., Ocean Springs, Miss.
Cavanaugh, Wm., Asst. Supv. B. & B., N. Y. C. R. R., Oswego, N. Y.
Cayley, W., Supv., G. T. Ry., Stratford, Ont.
Chapin, F. H., Asst. Br. Engr., Alaskan Eng. Com., Anchorage, Alaska.
Cheatham, S. W., Supv. B. & B., M. & O. R. R., Murphysboro, Ill.
Chesney, O. V., Supv. B. & B., S. P. Co., Portland, Ore.

Clapper, L., Engr., B. & B., D. & I. R., Two Harbors, Minn.
Clark, H. W., Supv. B. & B., Mo. Pac. R. R., Atchison, Kans.
Clark, J. H., M. of W. Clerk, Sou. Pac. Co., Tucson, Ariz.
Clark, W. A., Chief Engr., D. & I. R. R. R., Duluth, Minn.
Clarke, J. B., Mast. Carp., B. & O. R. R., Chillicothe, O.
Clopton, A. S., Supv. B. & B., M. K. & T. Ry., Oklahoma City, Okla.
Clothier, E. E., Chief Carp., C. M. & St. P. Ry., Mobridge, So. Dak.
Cochran, E. L., Br. Supv., Sou. Ry., Atlanta, Ga.
Coffin, J. E., Tim. Exp., Sou. Ry., Winston-Salem, N. C.
Coffin, S. P., Supv. B. & B., B. & M. R. R., Salem, Mass.
Colclough, E., Gen. For. B. & B., A. T. & S. F. Ry., Fresno, Calif.
Cole, J. E., Am. Opt. Co., 32 Coombs St., Southbridge, Mass.
Collings, Edwd., Chief Carp., C. M. & St. P. Ry., Perry, Iowa.
Conn, F. J., Supv. B. & B., C. N. O. & T. P. Ry., Lexington, Ky.
Cookingham, J. F., Mast. Carp., C. & E. I. R. R., Danville, Ill.
Cooper, H. A., Roadmaster, T. I. Ry., Gananoque, Ont.
Copland, A. C., Office Engr., C. & O. Ry., Richmond, Va.
Copp, J. P., Roberts & Schaeffer Co., McCormick Bldg., Chicago.
Corbin, W. S., For. B. & B., Sou. Pac. Co., San Pedro, Calif.
Corey, S. T., Asst. Br. Engr., C. R. I. & P. Ry., Chicago.
Corrigan, M. M., Gen. Insp. Tunnels, B. & O. R. R., Cumberland, Md.
Cota, G. M., Ch. Acct. Purch. Dept., C. Vt. Ry., St. Albans, Vt.
Cothran, J. M., Supv. B. & B., Sou. Ry., Rock Hill, S. C.
Counts, D. E., Supv. B. & B., N. C. & St. L. Ry., Atlanta, Ga.
Cowsert, L. A., Supv. W. S., C. N. O. & T. P. Ry., Danville, Ky.
Crawford, I. C., Supv. B. & B., D. & R. G. R. R., Salt Lake City.
Crawford, J. A., B. & B. Master, C. N. Ry., Saskatoon, Sask.
Creeks, J. L., For. B. & B., Sou. Pac. Co., Dunsmuir, Calif.
Crites, G. S., Div. Engr., B. & O. R. R., Baltimore, Md.
Cronin, Jno., Supv. B. & B., C. & N. W. Ry., Winona, Minn.
Crosby, P., Supv. B. & B., N. Y. N. H. & H. R. R., Danbury, Conn.
Crutchfield, A. O., Br. For., L. & H. R. R., Knoxville, Tenn.
Cullen, F. P., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Cullen, J. F., For. B. & B., O. S. L. R. R, Pocatello, Idaho.
Cunningham, A. O., Chief Engr., Wabash R. R., St. Louis, Mo.
Curry, Jno., For. B. & B., Mo. Pac. R. R., McGehee, Ark.
Curtin, William. Contractor, Govan, Saskatchewan.
Czamanske, O. H., Ch. Carp., C. M. & St. P. Ry., Portage, Wis.

Dalstrom, O. F., Br. Engr., C. & N. W. Ry., Chicago.
Danes, E. C., Supv. B. & B., Wabash R. R., Montpelier, Ohio.
Davidson, J. K., Mast. Carp., Pa. Lines W., Jamestown, Pa.
De Armond, Roy., Br. Insp., Sou. Pac. Co., Bakersfield, Cal.
Decker, H. H., Contractor, 2915 Ingersoll Ave., Des Moines, Iowa.
Demars, E. A., G. F. Plumb. & W. S., O. S. L. R. R., Salt Lake City
Demmon, H. R., Fire & Tunnel Insp., S. P. Co., Portland, Ore.
Denz, L. J., Ch. Carp., C. M. & St. P. Ry., Chicago.
Derham, H. M., Asst. Engr., O. S. L. R. R. Pocatello, Idaho.
Derr, W. L., C. G. W. R. R., Chicago, Ill.
de Ximeno, A., C. C. S. Corp., Obispo 59, altos, Havana, Cuba.
Dickson, Geo., For. Brdgs., Sou. Pac. Co., Oakland, Calif.
Dickson, G. H., Asst. Engr., B. &B., T. & N. O. Ry., North Bay, Ont.
Dillabough, J. V., Asst. Dist. Engr., C. N. Ry., Edmonton, Alta.
Dittmar, F. C., Br. For., Sou. Pac. Co., Los Angeles, Calif.
Dodd, A. M., Supv. B. & B., C. of Ga. R. R., Macon, Ga.
Donaldson, C. E., Supv. B. & B., C. Vt. R. R., St. Albans, Vt.
Douglas, L. H., Mast. Carp., B. & O R. R., Cleveland, O.
Doyle, Peter, Supv. B. & B., G. T. Ry., Montreal, Que.
Draper, F. O., Supt. of Brdgs., I. C. R. R., Chicago.
Draper, I. A., 216 N. 16th St., Kansas City, Mo.

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Gardner, E. F., Mast. Carp., Erie R. R., Buffalo, N. Y.
Garner, R. D., Engr. Const., S. N. E. Ry., Providence, R. I.
Gaut, J. B., Supt. B. & B., G. T. R., Detroit, Mich.
Gauthier, A. I., Supv. B. & B., B. & M. R. R., Concord, N. H.
Gehr, B. F., Mast. Carp., P. C. C. & St. L. Ry., Richmond, Ind
Gehrig, A. G., 4529 Fifth Ave., Los Angeles, Calif.
Gentis, Ira, For. B. & B., Sou. Pac. Co., Oakland, Calif.
George, E. C., Gen. For. B. & B., G. C. & S. F. Ry., Beaumont, Tex.
George, W. J., Bay Road, Claremont, W. Australia.
Gerst, H. A., Asst. Br. Engr., G. N. Ry., St. Paul, Minn.
Getman, Frank, Mast. Carp., Erie, Youngstown, O.
Gibson, H. R., Div. Engr., B. & O. R. R., Connellsville, Pa.
Gibson, J. M., Supv. B. & B., G. T. R. in New Eng., Portland, Me.
Gilkey, R. H., Supv. B. & B., C. of Ga. R. R., Savannah, Ga.
Gilman, A. F., 530 Ashland Ave., St. Paul, Minn.
Giusto, Peter, For. B. & B., Sou. Pac. Co., San Francisco.
Glass, J., Gen. For. Snow Sheds, S. P. Co., Donner, Calif.
Gnadt, C. C., Br. For., Mo. Pac. R. R., Desoto, Mo.
Goldmark, Henry, Cons. Engr., 103 Park Ave., New York City.
Goldsmith, E. L., Supt. Const., L. I. R. R., Jamaica, N. Y.
Golson, W. P., Roadmaster, C. of Ga. Ry., Macon, Ga.
Gongoll, O. C., Asst. Supt. B. & B., Soo Line, Minneapolis, Minn.
Gooch, C. W., 1325 W. 9th St., Des Moines, Iowa.
Goodman, Job., Supv. B. & B., Sou. Ry., Winston-Salem, N. C.
Graburn, H. R., Desig. Dftsman, Erie R. R., Hornell, N. Y.
Gradt, Chas., Ch. Carp., C. M. & St. P. Ry., Savanna, Ill.
Graham, F. N., Asst. Engr., D. M. & N. Ry., Duluth, Minn.
Granfield, W., Br. Insp., Sou. Pac. Co., Sacramento, Calif.
Gratto, James, Supv. B. & B., S. P. Co., Los Angeles, Calif.
Graves, Lon, For. B. & B., Mo. Pac. R. R., Dermott, Ark.
Green, C. F., Supv. B. & B., Sou. Pac. Co., Sacramento, Calif.
Green, E. H. R., Pres., Texas Midland R. R., Terrell, Tex.
Green, Z. A., Pilot, Fed. Val., G. C. & S. F. Ry., Galveston, Tex.
Gregory, Neal, Ch. Carp., C. M. & St. P. Ry., Milwaukee, Wis.
Greiner, J. E., Civil Engr., 605 Continental Bldg., Baltimore, Md.
Griffith, F. M., Supv. B. & B., C. & O. Ry., Covington, Ky.
Griffith, W. J., Mas. For., B. & A. R. R., Pittsfield, Mass.
Groeninger, H. J., Mast. Carp., P. R. R., Oil City, Pa.
Grover, J. H., Gen. For. W. S., A. T. & S. F. Ry., Needles, Calif.
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Guill, B. A., Supv. B. & B., Ga. R. R., Camok, Ga.
Guire, W. A., For. B. & B., Mo. Pac. R. R., Lake Providence, La.
Guppy, B. W., Engr., Structures, B. & M. R. R., Boston, Mass.
Guyton, S. W., Mast. Carp., Pa. Lines W., Logansport, Ind.

Haag, Orin, Carp. For., B. & O. R. R., Garrett, Ind.
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Haley, W. S., Asst. Div. Engr., N. Y. C. R. R., Toledo, O.
Hall, N. L., Roadmaster, Sou. Ry., Winston-Salem, N. C.
Hall, Thomas, Asst. Supt. Bldgs., M. C. R. R., Jackson, Mich.
Hamer, John, Supv. Bldgs., N. Y. C. R. R., Albany, N. Y.
Hampton, H. A., Asst. Div. Engr., Sou. Pac. Co., Portland, Oregon.
Hancock, John, Asst. Engr., N. Y. C. R. R., Crown Bldg., Cleveland, O.
Hand, Geo. W., Valuation Engr., C. & N. W. Ry., Chicago.
Hanks, G. E., 814 No. Wash. Ave., Saginaw, Mich.
Hansen, Robt., Carp. For. Sou. Pac. Co., West Oakland, Calif.
Hansen, Rupert, 829 Kensington Ave., Salt Lake City, Utah.
Hanson, J. A., Supv. B. & B., C. C. C. & St. L., Mt. Carmel, Ill.
Hargrove, J. C., Scale Insp., Mo. Pac. R. R., McGehee, Ark.
Harlow, A. W., Mast. Carp., Erie R. R., Huntington, Ind.
Harman, H. H., Engr. of Brdgs., B. & L. E. R. R., Greenville, Pa.

Harman, Wm. C., Br. Insp., Sou. Pac. Co., Tehachapi, Calif.
Harris, W. B., Roadmaster, M. & O. R. R., Murphysboro, Ill.
Harrison, Chas., Gen. For. B. & B., M. V. R. R., Muskogee, Okla.
Hartley, James, Supv. B. & B., N. P. Ry., Staples, Minn.
Hartwell, J. R., Supv. B. & B., P. R. C. & N. W. Ry., Pierre, S. D.
Harvey, E. H., For. B. & B., A. & L. M. Ry., Monroe, La.
Harvey, T. J.
Hatcher, H. L., Mast. Carp., S. A. L. R. R., Americus, Ga.
Hausgen, W., Supv. B. & B., Mo. Pac. R. R., Sedalia, Mo.
Hawk, A. T., Engr. Bldgs., C. R. I. & P. Ry., Chicago.
Hawken, F. G., Insp. B. & B., D. S. S. & A. Ry., Marquette, Mich.
Hawkins, E. P., Div. Engr., Mo. Pac. R. R., Osawatomie, Kans.
Hayes, J. L., Div. Engr., C. R. I. & P. Ry., Rock Island, Ill.
Hein, O. J., Draftsman, C. & N. W. Ry., Chicago.
Heissenbuttel, H., Supv. B. & B., C. & N. W. Ry., Norfolk, Neb.
Helick, R. H., Mast. Carp., P. R. R., Pittsburgh, Pa.
Henderson, J., For. B. & B., G. T. Ry., St. Thomas, Ont.
Henderson, R. C., Mast. Carp., B. & O. R. R., Dayton, O.
Henley, L., Genl. Br. For., S. A. L. R. R., Waldo, Fla.
Henry, R. F., Supv. B. & B., C. C. C. & St. L., Galion, O.
Heritage, C. S., Br. Engr., K. C. S. Ry., Kansas City, Mo.
Herrig, C., For. W. S., C. & N. W. Ry., Wall Lake, Iowa.
Heuss, C. W., Supv. B. & B., C. C. C. & St. L., Indianapolis, Ind.
Hewitt, G. G., Supv. B. & B., Sou. Ry., Greensboro, N. C.
Higgins, H. K., Const. Engr., 209 McBride St., Jackson, Mich.
Hill, H. R., Asst. Supv. B. & B., L. & N. R. R., Birmingham, Ala.
Hillman, F. W., Div. Engr., C. & N. W. Ry., Chicago.
Hinchee, J. M., For. B. & B., Sou. Pac. Co., Los Angeles, Calif.
Hinkle, C. L., Asst. Mast. Carp., Erie R. R., Youngstown, O.
Hitesman, U. S., Gen. For., N. Y. C. R. R., New York City.
Hodges, F. J., C. C., M. C. R. R., Jackson, Mich.
Hodges, H. P., 2031 Gartner Ave., Detroit, Mich.
Hofecker, Peter, Supv. B. & B., L. V. R. R., Auburn, N. Y.
Hoffman, Geo. M., For. Ptr., P. & R. Ry., Shamokin, Pa.
Holcomb, J. W., Supv. B. & B., L. V. R. R., Buffalo, N. Y.
Holdridge, H. D., Supv. B. & B., Y. & M. V. R. R., Vicksburg, Miss.
Hopke, W. T., Mast. Carp., B. & O. R. R., Grafton, W. Va.
Horning, H. A., Supt. of Bldgs., M. C. R. R., Jackson, Mich.
Horth, A. J., Mast. Carp., Erie R. R., Meadville, Pa.
Hotson, Wm. B., Supt. B. & B., E. J. & E. Ry., Joliet, Ill.
Howay, B. J., For. B. & B., P. M., Saginaw, Mich.
Howson, E. T., Ed. Mtce. Engr., 608 So. Dearborn St., Chicago.
Hubbard, A. B., 32 Banks St., West Somerville, Mass.
Hudson, B. M., Supt. T. & B. V. Ry., Teague, Tex.
Hull, H. L., C. C., Eng. Dept., C, T. H. & S. E., Chicago.
Hull, K. S., Gen'l Supt., G. C. & S. F. Ry., Galveston, Tex.
Humbert, A. T. Mast. Carp., B. & O. R. R., New Castle Jct., Pa.
Hume, E. S., Deputy Com'r., W. A. Govt. Rys., Perth, W. Australia.
Hunciker, John, For. Br. Erec., C. & N. W. Ry., Chicago.
Huntoon, J. S., Asst. Br. Engr., M. C. R. R., Detroit, Mich.
Hutchens, J. A., Gen. For. W. S., Sou. Pac. Co., Ogden, Utah.

Ilsley, A. B., Engr. Brgs., Sou. Ry., Charlotte, N. C.
Ingalls, F., Supv. B. & B., N. P. Ry., Jamestown, N. D.
Ingram, Floyd, Supv. B. & B., L. & N. R. R., Paris, Tenn.
Innes, J., Gen. For. G. T. Ry., Hamilton, Ont.
Irving, T. J., Div. Engr., C. & N. W. Ry., Boone, Ia.
Irwin, J. W., 819 No. 4th St., Niles, Mich.
Isaacs, Jno. D., Cons. Engr., Sou. Pac. Co., New York City.

Jack, H. M., 519 W. Kolstad St., Palestine, Tex.
Jackson, C. T., Dist. Engr., C. M. & St. P. Ry., Chicago.
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Jamison, G. H., 307 First Ave. So.; Seattle, Wash.
Jennings, Geo. H., Mgr., Powers-Thompson Const. Co., Joliet, Ill.
Jensen, C. A., For. B. & B., Sou. Pac. Co., Los Angeles, Calif.
Jewell, J. O., Supt. B. & B., C. T. H. & S. E. Ry., Terre Haute, Ind.
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Keith, H. C., Cons. Engr., 13 Park Row, New York City.
Keir, W. E., Gen. For. W. S., A. T. & S. F. Ry., San Bernardino, Calif.
Keggan, J. J., Mast. Carp., Erie R. R., Marion, O.
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Kelly, J. A., Supv. B. & B., O. S. L. R. R., Pocatello, Idaho.
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Killam, A. E., 84 Highfield St., Moncton, N. B.
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Knapp, G. A., 3616 Ave. S½., Galveston, Tex.
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Mayer, M. J., U. S. R. R. A., 65 Market St., San Francisco, Cal.
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McCann, E., Gen. For. B. & B., A. T. & S. F. Ry., Wellington, Kans.
McCaulley, S. W., Cons. Engr., 1428 E. 68th St., Chicago.
McClanahan, S. L., Div. Engr., C. R. I. & P. Ry., Herington, Kans.
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Replogle, J. S., For. B. & B., Sou. Pac. Co., Oakland, Calif.
Rettinghouse, H., 923 Dakota Ave. S., Sioux Falls, S. Dak.
Reynolds, A. W., Mast. Carp., P. R. R., Jersey City, N. J.
Reynolds, J. V., For. B. & B., Mo. Pac. R. R., McGehee, Ark.
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Rodman, G. A., Gen. Supv. B & B, NY NH & H RR, New Haven, Conn.
Rogers, W. A., Civil Engr., 37 W. Van Buren St., Chicago.
Rohbock, W. L., Ch. Engr., W. & L. E. R. R., Cleveland, O.
Rohr, E. J., Asst. Br. Supv., C. & O., 2192 Shadwell St., Cincinnati, O.
Rose, Norman, Supv. B. & B., Sou. Pac. Co., Portland, Ore.
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Rounseville, D., Asst. to Ch. Engr., C. & N. W. Ry., Chicago.
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Rykenboer, E. J., Supv. Bldgs., N. Y. C. R. R., Rochester, N. Y.

Sampson, G. T., 234 Main St., Medford, Mass.
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Strouse, W. F., 400 Forest Road, Baltimore, Md.
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Swenson, P., Supt. B. & B., M. St. P. & S. Ste. M. Ry., Minneapolis.

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Winter, A. E., C. E., 257 Cathedral Pl., St. Paul, Minn.
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Wise, E. F., 207 Clay St., Waterloo, Iowa.
Wishart, J. J., Supv. B. & B., N. Y. N. H. & H. R. R., Boston, Mass.
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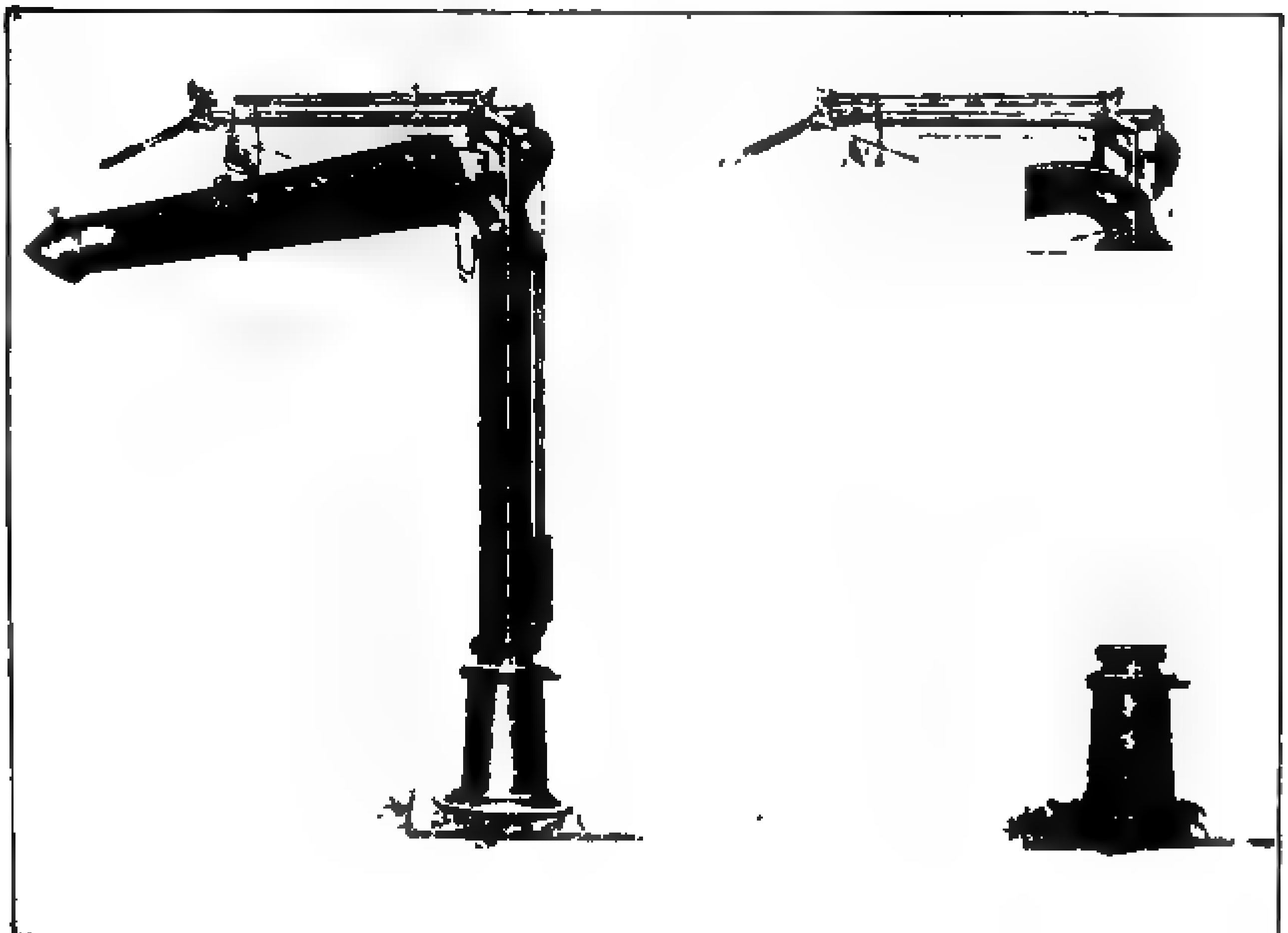

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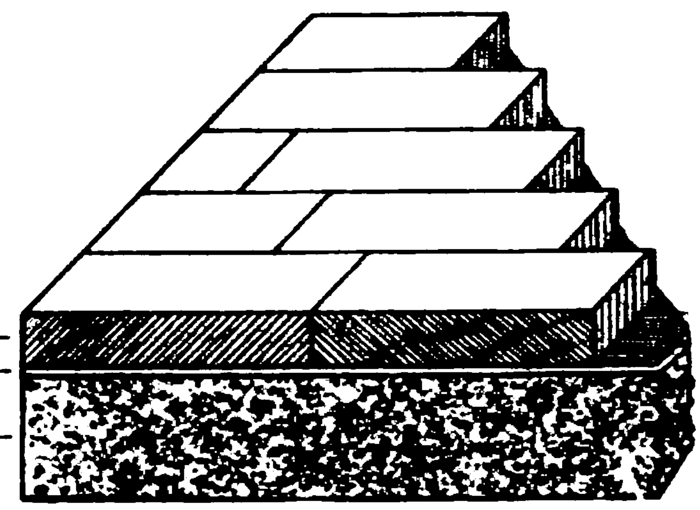

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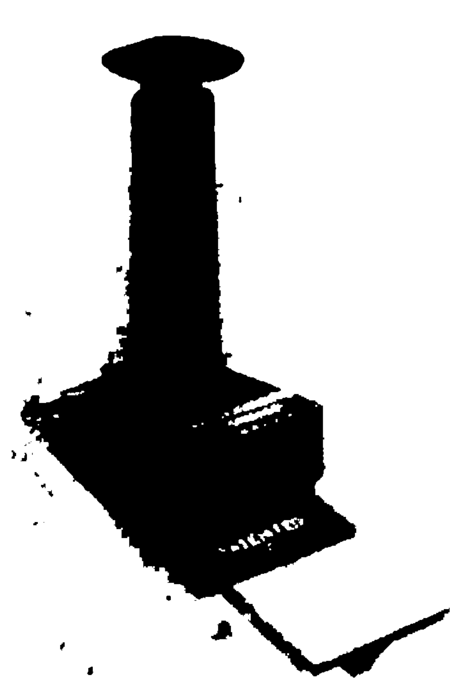

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